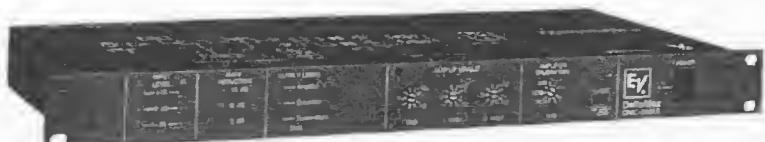




**Electro-Voice®**  
**THE DELTAMAX™ SYSTEM**

## **OWNER'S MANUAL**



**DMC-2181X CONTROLLER**  
**DMS-2181 LOUDSPEAKERS**

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**WARNING: TO REDUCE THE RISK OF FIRE OR ELECTRIC SHOCK,  
DO NOT EXPOSE THIS EQUIPMENT TO RAIN OR MOISTURE.**

**DESCRIPTION****GENERAL**

The DeltaMax™ DMC/DMS-2181 system consists of the DMS-2181 high-performance Manifold Technology® subwoofer speaker system and the companion DMC-2181X electronic controller. The DMC/DMS-2181 subwoofer system is intended for use with one of the full-range DeltaMax™ systems (such as the DMC/DMS-1122 or DMC/DMS-1152) for high-level sound reinforcement in touring-sound and permanent-installation applications. Although this manual describes the use of the DMC-2181 speaker system, the DMC-2181X controller works equally as well with the DMS-1181 speaker system. The unique circuitry of the DMC-2181X controller provides accurate protection for the subwoofers without the use of shifting high-pass or low-pass filters, shifting crossover frequencies, or independent band-pass compression; and the electronic protection is invoked only when catastrophic conditions are present for the subwoofers. The left and right high-pass output signals (above 80 Hz) are unprotected and are intended to be sent to a pair of full-range DMC-controller/DMS-loudspeaker systems. The result is that accurate frequency response is maintained from the lowest sound pressure levels to the very highest sound pressure levels available from the loudspeakers. The compact DMS-2181 enclosure allows tight-cluster designs, enabling maximum mutual coupling and single-point-source arrays. There are two models in the DMS-2181 series: the DMS-2181AP (painted finish) and the DMS-2181APF (painted finish with flying hardware).

The DMS-2181 is a vented-box design comprised of two EVX-180A 18-inch woofers, each facing into a manifold chamber at the center of the cabinet. Manifold Technology® (U.S. Patent No. 4,733,749) results in increased acoustic loading, yielding increased low-frequency efficiency and reduced distortion over conventional direct-radiating designs.

The DMS-2181APF flying version includes two lengths of aircraft-type L-track rigging hardware on the top and bottom of the enclosure. These fittings ease the hanging of multi-cabinet arrays. Each DeltaMax™ flying system is packed with a separate owner's manual which provides specific hanging instructions.

The DMC-2181X circuits are designed to provide optimum audio performance, even when the audio drive level is increased for maximum loudness. Unusually accurate speaker modeling circuits control a high-performance compressor and voltage limiter which provide speaker excursion protection, voice-coil temperature protection and amplifier maximum-power limiting.

Optimum performance of the DMS-2181AP and DMS-2181APF will occur only when used with the DMC-2181X. Although maximum protection is not available, the DeltaMax™ systems are also effectively controlled via the Electro-Voice Dx34 digital crossover system.

**FEATURE SUMMARY**

- Fourth-order Linkwitz-Riley crossover filters provide smooth, accurate response through the crossover region.
- Special equalization circuits allow flat, wide-band system response.
- Sending circuits for the drivers control the compressor and voltage limiter to prevent voice-coil overheating, over-excursion and amplifier clipping without affecting spectral balance or program dynamics.
- Dual-time constant compressor circuit with variable compression ratio reduces peak and average levels for loudspeaker thermal protection and amplifier clipping prevention, as necessary, while preserving relative program dynamics.
- Connection to the compressor control voltage is available through a jack on the back panel. This allows precise gain tracking when more than one unit is in use, or between the subwoofer controller and other DeltaMax™ controllers.
- Front panel display shows the drive signal level of each channel and resulting sub-channel compressor gain reduction. Sensing display shows amplifier limit, excursion limit and temperature limit. When its limit is approached, each LED lights yellow.
- Speaker system is compact for tight-cluster array designs. Flying versions feature integral, aluminum-reinforced fittings to ease hanging.
- The woofers utilize the latest technology for high power and accurate sound reproduction.
- Manifold Technology® employed for maximum low-frequency loudspeaker performance.

CONTROLLER SPECIFICATIONS	
<b>CHANNEL CONFIGURATIONS:</b> Stereo two-way; one sense channel	<b>Maximum Level,</b> 145 V rms
<b>FILTER TYPE:</b> 4th-order Linkwitz-Riley	<b>Impedance:</b> 100 kilohms each side to ground
<b>CROSSOVER FREQUENCY:</b> 80 Hz	<b>Connector:</b> Two five-way binding posts
<b>GAIN:</b> 6 dB nominal, equalized sub output, unity gain high output	<b>OUTPUTS (Sub and High),</b> <b>Type:</b> Electronically balanced differential
<b>TOTAL HARMONIC DISTORTION, 20-20,000 Hz</b> 0.03% typical, 0.1% maximum	<b>Maximum Level:</b> +18 dBu
<b>NOISE, EACH OUTPUT, 20-20,000 Hz NBW, TYPICAL,</b> -86 dBu	<b>Minimum Load Impedance for Full Level:</b> 600 ohms
<b>SIGNAL INPUTS,</b> <b>Type:</b> Electronically balanced differential	<b>Connectors:</b> Male 3-pin XLR-type
<b>Maximum Level:</b> +18 dBu	<b>POWER REQUIREMENTS:</b> 100, 120, 220, 240 V ac, 50 - 60 Hz, 13 W
<b>Impedance:</b> 20,000 ohms	<b>CHASSIS CONSTRUCTION:</b> Painted steel
<b>CMRR, Typical:</b> -55 dB	<b>COLORS:</b> Gray front panel/black chassis with white graphics
<b>Connector:</b> Female 3-pin XLR-type	<b>OUNTING:</b> EIA 19-inch rack mount, 1.75 in. high, 8.25 in. behind panel (excluding connectors); supplied with front-panel security cover for controls.
<b>SENSE CHANNEL INPUTS,</b> <b>Type:</b> Floating differential	
SYSTEM SPECIFICATIONS – DMS-2181/DMC-2181X	
Frequency Response (measured in far field, with and without crossover and equalization, calculated to one meter on axis, swept sine wave, one watt into system - 2.00 V at 60 Hz, anechoic environment; see Figure 1): 37-200 Hz	<b>Third Harmonic,</b> 40 Hz: 0.3% 80 Hz: 0.2%
Crossover Frequency: 80 Hz	<b>Transducer Complement:</b> Two EVX-180A 18-in. woofers
Efficiency: 6.8%	<b>Impedance (see Figure 7),</b> <b>Nominal:</b> 4 ohms
Maximum Long-Term-Average Power-Handling Capacity (per ANSI/EIA RS-426A 1980): 1,200 watts	<b>Minimum:</b> 3.3 ohms
Maximum Long-Term-Average Midband Acoustic Output: 82 acoustic watts	<b>Input Connections:</b> Two Neutrik NL4MPR Speakon® connectors paralleled
Sensitivity (SPL at one meter, indicated input power, anechoic environment, average level), 1 watt: 99.5 dB	<b>Recommended Amplifier Power:</b> 1,200-2,400 watts
1,200 watts: 130.5 dB	<b>Enclosure Construction,</b> <b>Shell:</b> 18 mm, 13-ply birch plywood
Beamwidth (angle included by 6-dB-down points on polar responses, indicated one-third-octave bands of pink noise; see Figures 3 and 4), Horizontal, 63-100 Hz: 285° (+75°, -52°)	<b>Finish:</b> Black textured paint
Vertical, 63-100 Hz: 240° (+120°, -77°)	<b>Grille:</b> Vinyl-coated steel with foam
Directivity Factor, $R_g(Q)$ , 63-100 Hz Average (see Figure 5): 1.9 (+0.3, -0.2)	<b>Rigging (DMS-2181PF only):</b> Two-point heavy-duty L-track system, accepts New Haven NH32102-2 double-stud fittings, or New Haven NH8192-2S or Anra 42546-10 single-stud fittings with safety pins
Directivity Index, $D_g$ , 63-100 Hz Average (see Figure 5): 2.8 dB (-0.6 dB, -0.6 dB)	<b>Dimensions,</b> <b>Height:</b> 914 mm (36.00 in.)
Distortion (115 dB SPL at one meter, shaped spectrum; see Figure 6), Second Harmonic, 40 Hz: 0.6%	<b>Width:</b> 572 mm (22.50 in.)
80 Hz: 0.3%	<b>Depth:</b> 759 mm (29.88 in.)
	<b>Net Weight:</b> 88.6 kg (191 lb)
	<b>Shipping Weight:</b> 90.7 kg (200 lb)

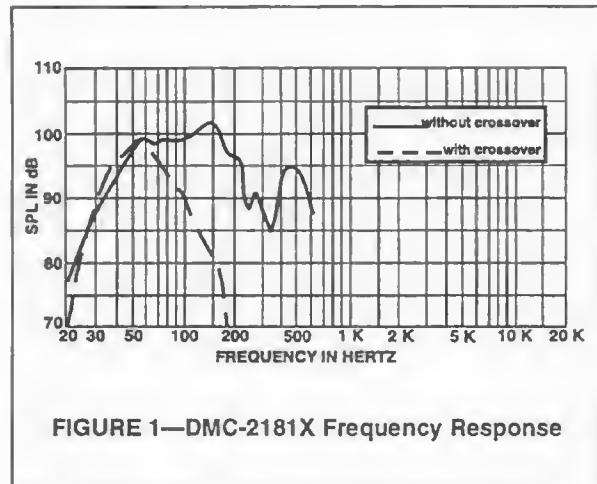


FIGURE 1—DMC-2181X Frequency Response

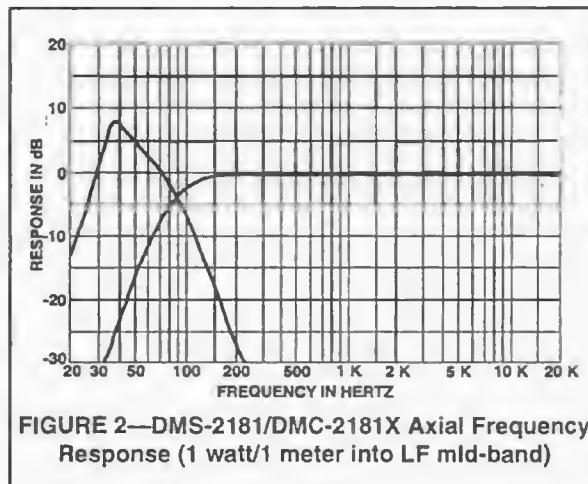


FIGURE 2—DMS-2181/DMC-2181X Axial Frequency Response (1 watt/1 meter into LF mid-band)

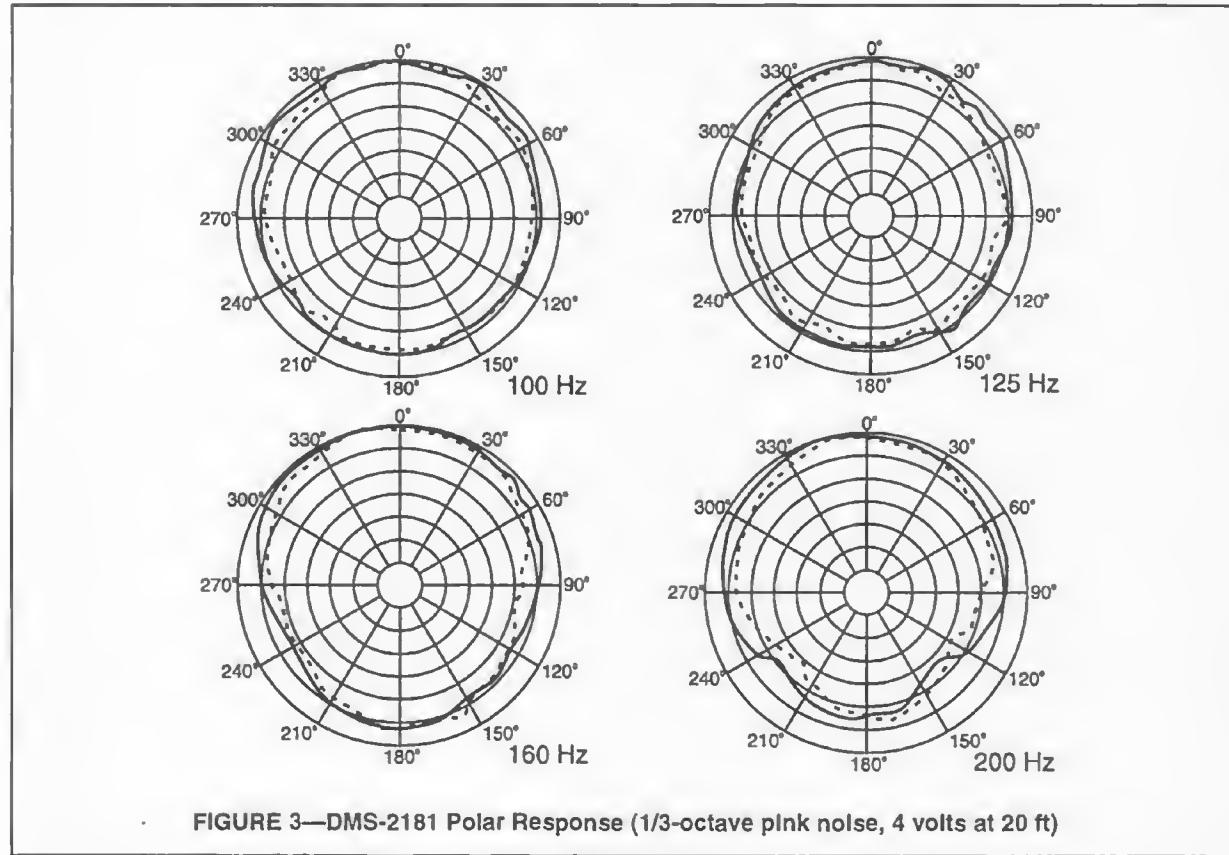


FIGURE 3—DMS-2181 Polar Response (1/3-octave pink noise, 4 volts at 20 ft)

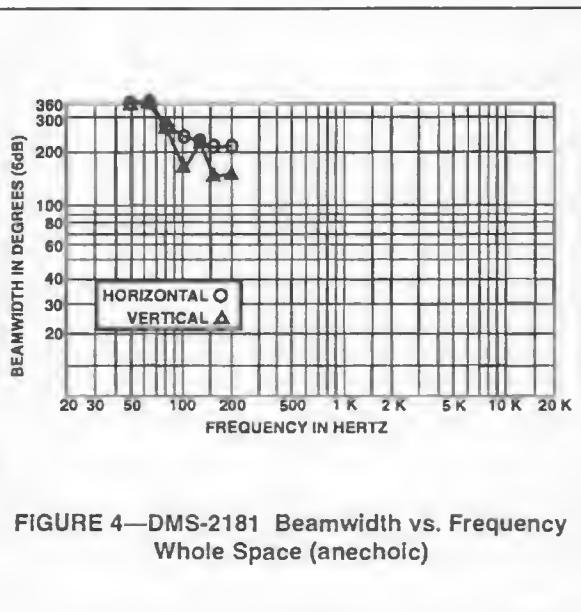


FIGURE 4—DMS-2181 Beamwidth vs. Frequency Whole Space (anechoic)

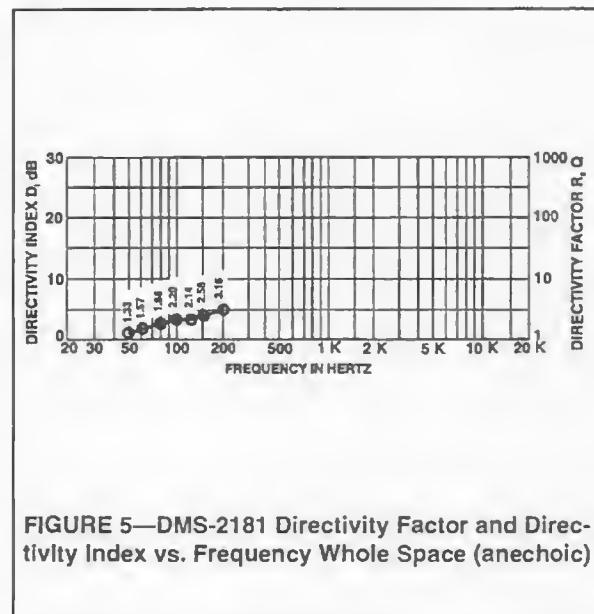


FIGURE 5—DMS-2181 Directivity Factor and Directivity Index vs. Frequency Whole Space (anechoic)

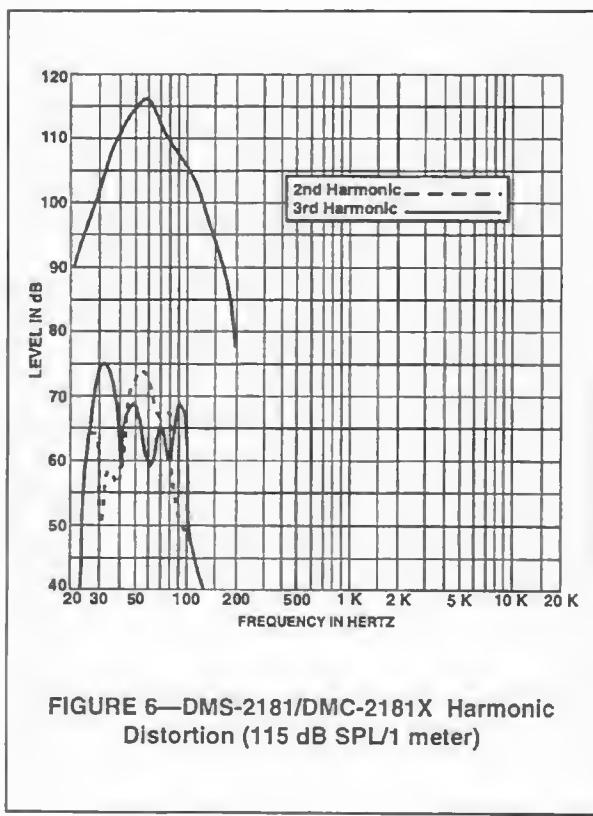


FIGURE 6—DMS-2181/DMC-2181X Harmonic Distortion (115 dB SPL/1 meter)

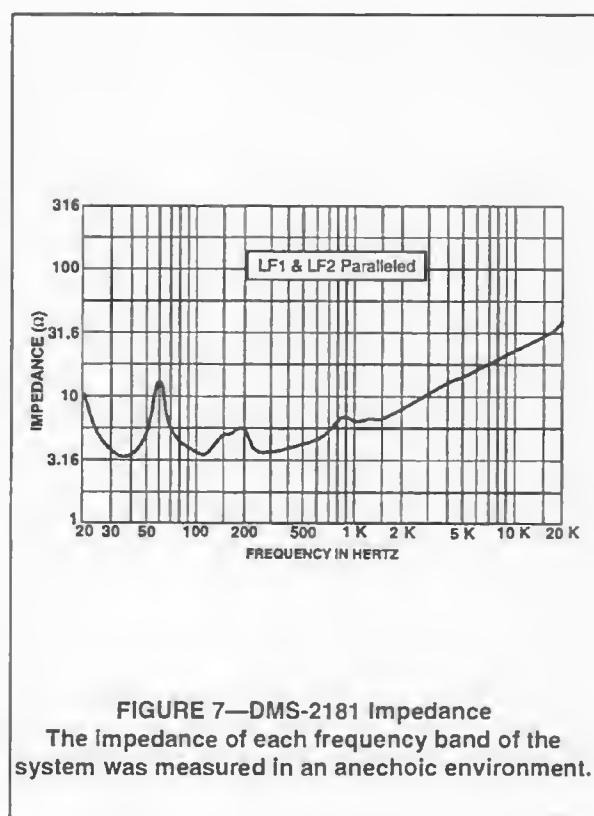
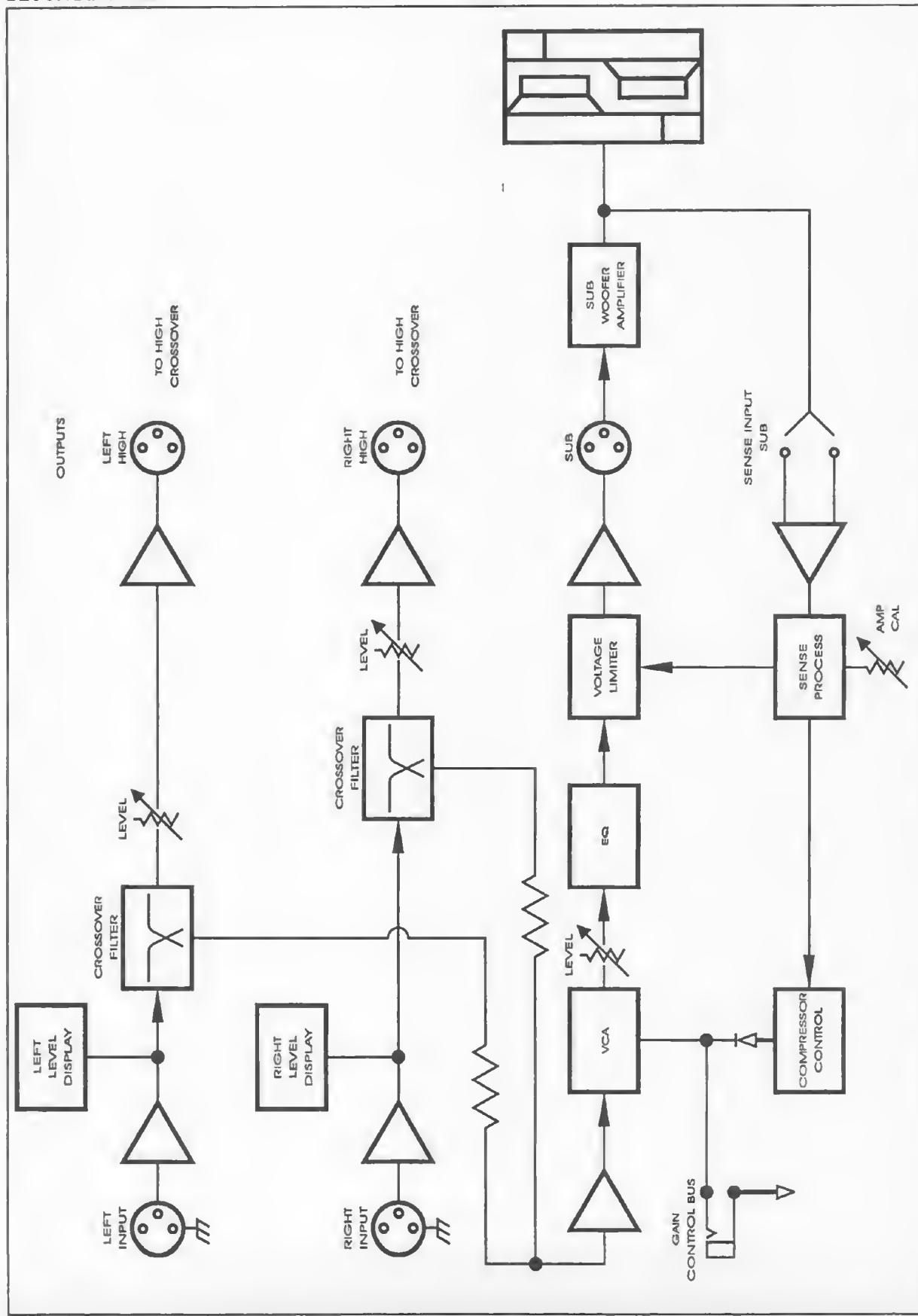


FIGURE 7—DMS-2181 Impedance  
The impedance of each frequency band of the system was measured in an anechoic environment.

## BLOCK DIAGRAM



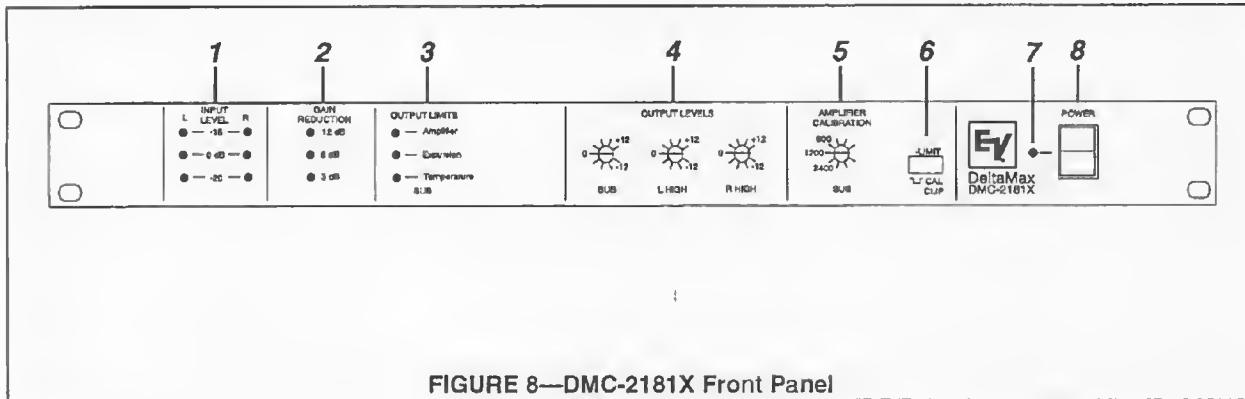


FIGURE 8—DMC-2181X Front Panel

## OPERATION

### FRONT PANEL INDICATORS AND CONTROLS

1. **INPUT LEVEL INDICATORS:** Three LED's show the drive level input channel of the DMC-2181X. Levels are calibrated in dBu (-20, 0, +16).

NOTE: Do not allow the 16-dB input-level indicator to stay on continuously. If the 16-dB indicator is allowed to stay on for long periods, the input circuit will clip. The input signal should be reduced until the 16-dB indicator lights only on loud, instantaneous peaks.

2. **GAIN REDUCTION INDICATORS:** Three LED's show how much gain reduction is occurring in the compressor at the input of the controller. The display is calibrated in relative dB (3, 6, 12). Gain reduction occurs only when the maximum temperature, excursion or amplifier capabilities are exceeded for the subwoofers. The Output Limits display indicates which limits are being exceeded when gain reduction occurs.

NOTE: Do not allow the 12-dB-gain-reduction indicator to stay on continuously. If the 12-dB indicator is allowed to stay on for long periods, the speakers may be damaged. The input signal should be reduced until the 12-dB indicator lights only on loud passages.

3. **OUTPUT LIMIT INDICATORS:**

A. **TEMPERATURE LIMIT:** These LED's light when the temperature of the subwoofer voice coils approach their maximum allowable limit. Under this condition, gain reduction will occur at the input of the controller so that the maximum-temperature limits will not be exceeded for the subwoofers.

B. **EXCURSION LIMIT:** These LED's light when the excursion of the subwoofer cones approach their maximum allowable limit. Under this condition, voltage clamping will occur at the output of the subwoofer section so that the maximum-excitation limits will not be exceeded for the subwoofers.

C. **AMPLIFIER LIMIT:** These LED's will provide status information for the subwoofer power amplifiers if the controller has been calibrated to the amplifiers—see the AMPLIFIER/CALIBRATION section. With the Cal/Clip Limit switch pressed

in, the LED's will signal the occurrence of amplifier clipping. With the switch in the outward position, the LED's indicated that gain reduction in the form of hard limiting is occurring at the input of the controller to prevent the amplifiers from clipping.

4. **OUTPUT LEVEL CONTROLS:**

A. **SUB:** This control adjusts the level of the subwoofer output signal (below 80 Hz). The control range is from -12 to +12 dB.

B. **L HIGH and R HIGH:** These controls adjust the level of the high-pass output signals (above 80 Hz) sent to the inputs of a pair of full-range DMC controllers. The control ranges are from -12 dB to +12 dB.

NOTE: The gain has been structured within the DMC-2181X controller so that when the DMC/DMS-2181 combination is used with one of the full-range DeltaMax™ systems (like the DMC/DMS-1122 or DMC/DMS-1152), the entire combination will have a flat-frequency response in an anechoic environment with the output levels of the controllers set in the 0-dB-detent position and with the amplifier channels having identical gain.

5. **AMPLIFIER CALIBRATION CONTROLS:** These controls are used for calibrating the controller to the subwoofer amplifiers, so that the controller can monitor the clipping of the amplifier outputs and, if desired, act as a limiter to prevent amplifier clipping. See AMPLIFIER /CONTROLLER CALIBRATION section.

NOTE: The calibrated markings on the front panel correspond to the power level that an amplifier would deliver to an 8-ohm load. A crude, approximate calibration can be obtained by rotating the control until the slot of the trimpot points at a power level equivalent to the amplifier power rating for an 8-ohm load. (When the trimpot is in its mid position, it is pointing at 1200 watts.)

6. **CAL/CLIP LIMIT SWITCH:** This switch selects the mode that controller will monitor the amplifiers (assuming that the controller has been calibrated to the amplifiers—see AMPLIFIER/CONTROLLER CALI

## OPERATION (continued)

BRATION section). With the switch pushed in, the Amplifier Limit LED's will indicate when the amplifiers are clipping. With the switch in the outward position, the Amplifier Limit LED's will indicate that gain reduction is occurring to prevent the amplifiers from clipping.

NOTE: If the controller has not been calibrated to the subwoofer amplifiers, the Cal/Clip Limit switch should be pushed in. This will defeat the compressor/limiter from trying to prevent amplifier clipping. (The Amplifier Limit LED's will still flash when the amplifier exceeds the power levels that the Amplifier Calibration trim pots are set to.) Poor sound quality can result with incorrect calibration and the compressor/limiter engaged.

7. **POWER INDICATOR:** This LED lights when the controller is on.
8. **POWER SWITCH:** This switch turns the controller on and off.

## BACK PANEL CONNECTIONS

1. **AC POWER CORD RECEPTACLE:** This receptacle is for the provided ac power cord.
2. **FUSE RECEPTACLE:** This fuse receptacle requires either a 0.174A 250 V slow-blow fuse (for 100/120 V ac operation), or a 0.100A 250 V slow-blow fuse (for 220/240 V ac operation).
3. **SUB SENSE INPUT:** This input is for connection of the sense line to monitor the power delivered to the subwoofers and should be connected to the output of the subwoofer amplifier.

NOTE: The Sense Input is a floating differential with a 5-way binding post. See CONNECTOR AND CABLE REQUIREMENTS section for detailed wiring information.

4. **OUTPUTS:**

- A. **SUB:** This connection is the subwoofer output (below 80 Hz) of the DMC crossover/controller and should be connected to the input of the subwoofer amplifier.
- B. **R HIGH and L HIGH:** These connections are the high-pass outputs (above 80 Hz) of the crossover/controller and should be connected to a pair of full-range DeltaMax™ controller systems for full-range stereo reproduction.

NOTE: The Sub and High outputs are transformer balanced XLR-type connectors having pin 1 as a ground reference, pin 2 high (+) and pin 3 (-). See CONNECTOR AND CABLE REQUIREMENTS section for detailed wiring information.

5. **GAIN CONTROL BUS:** This 1/4-inch jack is for slaving the gain-control buses of other DMC controllers to enable gain tracking in a multiple-controller system. See CONNECTOR AND CABLE REQUIREMENTS section for detailed wiring information.
6. **INPUT:** These connections are for the full-range rights and left stereo signal inputs to the DMC controller. These inputs are electronically balanced with female 3-pin XLR-type connectors with pin 1 as a ground reference, pin 2 high (+) and pin 3 low (-). See CONNECTOR AND CABLE REQUIREMENTS section for detailed wiring information.

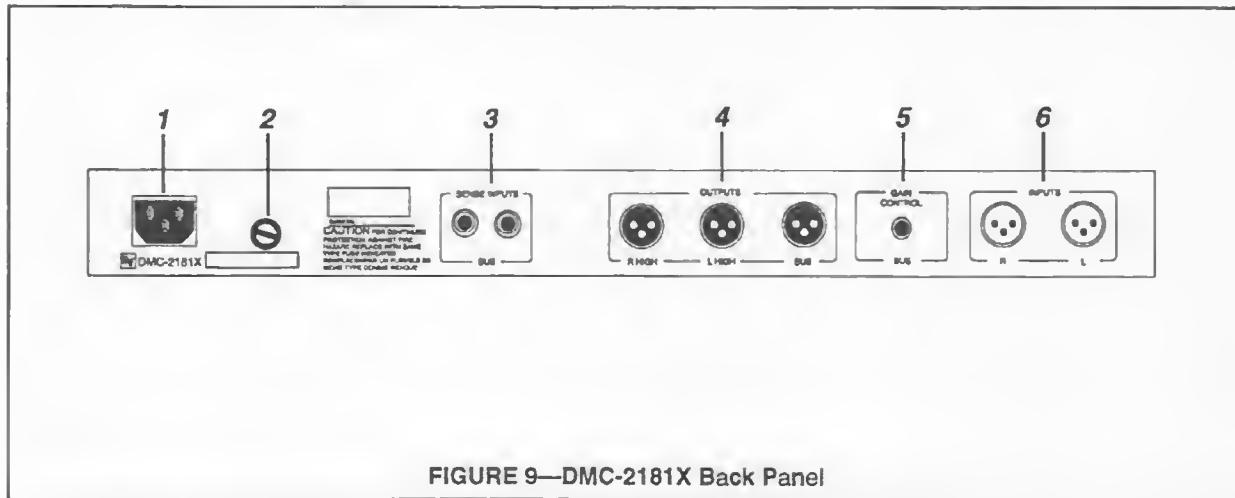


FIGURE 9—DMC-2181X Back Panel

**OPERATION (continued)****TYPICAL SYSTEM OPERATION**

The DMS 2181 is a subwoofer loudspeaker system to be used with the DMC-2181X electronic controller. The DMC/DMS 2181 subwoofer system is intended for use with one or two full-range DeltaMax™ electronically controlled loudspeaker systems (such as the DMC/DMS-1122 or DMC/DMS-1152). Besides conventional frequency division, the DMC-2181X controller has equalization and time delay to obtain optimum performance from the DMS-2181 when used with a full-range DeltaMax™ system. A sense line to the controller monitors the voltage drive to the subwoofers and automatically activates the protection circuitry to prevent cone over-excitation, voice-coil overheating and amplifier clipping. The right and left high outputs are unprotected and are intended to be sent to the inputs of a pair of full-range DMC-controllers/DMS-loudspeaker systems. (Protection for the full-range speakers will take place in the full-range controllers.) Before operating a DeltaMax™ system, the user should read this manual thoroughly and make sure that the system has been set up as detailed in the INSTALLATION section and the amplifiers and controllers have been calibrated as detailed in the AMPLIFIER/CONTROLLER CALIBRATION section.

The gain and equalization structures in the DMC controllers have been set up so that the DMS loudspeaker systems will have a flat frequency response (in an anechoic environment) when the Output Level trimpots on the controllers are set in the 0-dB-detent position and the amplifiers all have the same gain (i.e., the amplifiers are calibrated for 32 dB of gain as detailed in the AMPLIFIER/CONTROLLER CALIBRATION section). This gives the user a standard reference every time the system is set up. Adjustments to the drive levels of the low-and high-frequency sections are then only needed to compensate for room acoustics or array configurations. When adjustments are required, they should be made with the Output Level trimpots on the controllers. The level controls on the amplifiers should be left in their calibrated positions. (See the MULTIPLE LOUDSPEAKER ARRAY section for circumstances when it is permissible to adjust the amplifier level controls.)

The input circuit of the DMC controllers clips with a +18 dBu (6.2 volts rms) input signal. The input-signal level display has three LED's calibrated to -20, 0 and +16 dBu. To avoid clipping, the input should be driven only to the point that the +16 dBu LED lights on instantaneous peaks. If more gain is desired from the controller, the Output Level trimpots may be turned up. Note that there are calibrated markings on the front panel of the controller (3 dB per division) to enable accurate gain adjustments.

Extensive modeling circuits allow the controller to monitor the status of the voice-coil temperature and the cone excursion of the subwoofer loudspeakers. If a loudspeaker approaches its maximum thermal limit, a multi-time-constant compressor circuit with a variable compression ratio will reduce the peak and average levels of the drive signal as necessary to protect the drivers, while preserving the spectral balance and the relative program dynamics. When gain reduction occurs, an Output Limit

Temperature LED will light indicating that the subwoofers are reaching their thermal limit. If a subwoofer approaches its maximum excursion limit, a dynamic frequency-sensitive voltage-clamping circuit at the output of the subwoofer band will clamp the peak of the output waveform at a level above which excursion damage would occur to the loudspeaker, hence, preserving the overall spectral balance. When voltage clamping occurs, an Output Limit Excursion LED will light indicating that the subwoofers are reaching their excursion limit.

The DMC-2181X controller can also prevent long-term amplifier clipping. The controller must be calibrated as detailed in the AMPLIFIER/CONTROLLER CALIBRATION section and the Cal/Clip Limit switch must be in the Out position for this function to work properly. If the subwoofer amplifiers approach clipping, a multi-time-constant compressor-limiter circuit will reduce the peak and average levels of the drive signal as necessary to prevent long-term clipping, while preserving the overall spectral balance. When gain reduction occurs, an Output Limit Amplifier LED will light indicating that the subwoofer amplifiers are reaching their power limit. With the Cal/Clip Limit switch pushed in, gain reduction will not occur to prevent amplifier clipping and the Output Limit Amplifier LED's will simply indicate when the amplifiers are going into clipping.

The DeltaMax™ DMC controllers provide protection for the loudspeakers without affecting the overall spectral balance or dynamic range. The controllers have an LED display to inform the user when the protection circuitry is activated and what is causing the protection to take place. Each frequency band has three LED's to indicate loudspeaker thermal protection activation, loudspeaker excursion protection activation and amplifier clipping (or amplifier clipping prevention). In addition, there is an LED display to indicate the amount of long-term overall gain reduction occurring due to loudspeaker thermal protection and amplifier clipping prevention. (The instantaneous loudspeaker excursion voltage-clamping protection is not reflected in the overall gain-reduction display.)

In very high-powered applications, the detailed displays on the DMC controllers provide the user with information to make adjustments or changes to the system (if desired) to eliminate the protection and increase the acoustic output. For example:

- If an excessive amount of low-frequency excursion protection is occurring, selective equalization can be used (one-third-octave-band equalizer, parametric equalizer, etc.) to reduce the frequency range that is causing the excessive excursion, allowing the overall level to be turned up. If the desired amount of high-level low-frequency response still cannot be obtained, subwoofers (or additional subwoofers (or additional subwoofers) should be added to the system.
- If an excessive amount of loudspeaker thermal protection is occurring in any frequency band, more speaker systems are generally needed. If the program material has a lot of energy concentrated in a relatively small frequency range, selective equalization may serve as an effective compromise.

**OPERATION (continued)**

- If excessive amplifier clipping (or amplifier clipping prevention) is occurring without excessive loudspeaker thermal protection or excursion protection, larger power amplifiers should be used.
- If excessive loudspeaker thermal protection and excursion protection is occurring, more speakers should be used.
- If excessive overall gain reduction is occurring, more speakers should be added.
- If the 12-dB-gain-reduction LED is on for any significant portion of time, the level should be turned down. Levels driven beyond this point may exceed the protection capability of the protection circuitry.

When multiple DMC-2181X controllers are used, the control voltages should be slaved together as detailed in the INSTALLATION section. The gain of all of the controllers will then track whenever gain reduction occurs due to loudspeaker thermal protection or amplifier clipping prevention, regardless of which loudspeaker or amplifier was exceeding its limit. This will prevent acoustic image shifting at very high levels. When a DMC/DMS-2181 subwoofer system is used with full-range DeltaMax™ systems (such as the DMC/DMS-1122 or DMC/DMS-1152), the control voltages should be slaved together to prevent spectral balance shifting at high levels when gain reduction occurs for loudspeaker thermal protection or amplifier clipping prevention. The voltage-clamping loudspeaker excursion protection will still operate independently in each frequency band in each controller when the control voltages are slaved.

**AMPLIFIER/CONTROLLER CALIBRATION****AMPLIFIER CALIBRATION PROCEDURE**

Maximum performance of the DeltaMax™ controller protection circuitry occurs, under the most severely overdriven conditions, when the voltage gain of the amplifiers fall in the range of 27 to 35 dB (with 32 dB being optimum). This gain range is typical of most high-power amplifiers and can easily be adjusted by simply adjusting the level controls on the amplifier.

The procedure for calibrating an amplifier to have 32 dB of gain is as follows:

1. With the amplifier turned on and without speakers hooked on the amplifier output, apply 0.5-volt rms, 1,000-Hz sinewave signal to the input of the amplifier.
2. Adjust the level control until the output of the amplifier measures 20 volts rms.

NOTE: If the amplifier will be operated in the mono-bridged mode, it should be calibrated when wired in the mono-bridged configuration.

**CONTROLLER CALIBRATION PROCEDURE**

This procedure is for calibration of the DMC controller's internal amplifier limit circuits to the actual clip level of the subwoofer power amplifiers.

Before plugging in the ac power cord, be sure the controller is wired for the correct primary (mains) voltage.

**Disconnect the speakers and remove the security cover from the controller by removing two screws on the front panel of the controller. Perform the following procedure:**

1. Connect the controller to the subwoofer power amplifier channels as detailed in the INSTALLATION section.
2. Be sure the controller Sub Sense input is connected to the amplifier output and the speakers are disconnected from the amplifier.
3. Set the subwoofer amplifier gain controls for 32 dB voltage gain, or as close as possible to 32 dB (this is optimum, but it can be in the range of 27 to 35 dB). See the AMPLIFIER CALIBRATION PROCEDURE section.
4. Turn the Sub Amplifier Calibration trimpot on the controller to full counterclockwise. Press the Cal/Clip Limit switch to its recessed Cal/Clip position with a screwdriver or other suitable tool.
5. In order to prevent thermal limiting from occurring while calibrating the amplifier-limit levels, insert a shorted 1/4-inch phone plug (tip-sleeve) into the Gain Control Bus jack on the back of the controller. The thermal limit LED may still come on but no gain reduction should be indicated.
6. Send a 40-Hz sinewave test signal to the controller input.
7. Adjust the signal source level until the subwoofer amplifier begins to clip (you may turn up the Sub Output Level on the controller if necessary to get the amplifier to clip). Clipping is noted by the clip indicator on the power amplifier or by monitoring the output with an oscilloscope. Now, turn the level down until the clip light just goes out (or until the clipping disappears on the oscilloscope).
8. Turn the Sub Amplifier Calibration trimpot on the controller clockwise with a screwdriver until the Sub Amplifier Output Limit LED comes on. Note that the slot of the trimpot is pointed at the approximate power rating of the amplifier for an 8-ohm load as denoted by the calibrated marking on the front panel of the controller. Note that this is the maximum amount of power capable of being delivered to a single driver in this amplifier configuration.
9. Remove the shorted 1/4-inch phone from the Gain Control Bus jack and set the Cal/Clip Limit switch to the Limit position (out). Set the Sub Output Level control to its center-detent position (or as desired).
10. Turn the amplifier off and connect the speaker cables to the output of the amplifier. Be sure to observe polarity when making these speaker connections.

**NOTES:**

- A. The Amplifier Calibration trimpots may be adjusted during use with program material to set the desired amount of amplifier limiting. The limiter in the controller will allow some fast transient peaks through, allowing some amplifier clipping to occur. The limiter circuit will, however, prevent long-term amplifier clipping when adjusted properly.

## AMPLIFIER/CONTROLLER CALIBRATION (Continued)

- B. The Cal/Clip Limit switch may be left in the recessed Cal/Clip position if the power amplifier has an internal limiter, or if clip protection is not desired. When left in the Cal/Clip position, the Amplifier Output Limiter indicators on the front panel of the controller will indicate when the amplifier is self-limiting or clipping.
- C. If two or more speakers are connected in parallel to an amplifier output, most amplifiers will exhibit a drop in clipping voltage due to the lower load impedance. This will require that the Amplifier Calibration trimpot be set to a value slightly lower than the value obtained in the "no-load" calibration test.

Note that the result of this is that even when multiple speakers are paralleled on an amplifier channel, the Amplifier Calibration trimpot will always end up pointing at the maximum amount of power (on the calibrated marking on the front panel) that the amplifier is capable of delivering to each individual driver no matter how many drivers are connected in parallel.

- D. Do not change the amplifier gain, or recalibration will be necessary. Use the Output Level controls on the controller to change power amplifier drive levels.

## INSTALLATION

### AMPLIFIER REQUIREMENTS

The DMS-2181 subwoofer system contains two 8-ohm drivers. Each system utilizes a 4-pin electrical connector that allows each driver to be accessed separately. There are two ways the system may be powered:

1. Each driver may be connected to its own separate amplifier channel. In this configuration, each amplifier channel should have a power rating of 600-1,200 watts into eight ohms. The amplifier channels must be identical, having the same voltage gain and power rating.
2. The two drivers may be paralleled to one amplifier channel. The speakers should be paralleled at the amplifier, not at the cabinet. In this configuration, the amplifier channel should have a power rating of 1,200-2,400 watts into four ohms.

DMS-2181 systems may be paralleled (in either of the above configurations) with other DMS-2181 systems if the amplifier is capable of delivering adequate power to each speaker at the lower impedance.

NOTE: For proper operation of the protection circuitry, the power amplifiers must be calibrated to have a voltage gain between 27 and 35 dB (32 dB is optimum). See the AMPLIFIER/CONTROLLER CALIBRATION section.

## CONNECTOR AND CABLE REQUIREMENTS

### Controller Connections

The DeltaMax™ controllers have 3-pin XLR-type connectors for signal input and output. The input and output. The inputs are electronically balanced female connectors with pin 1 as a referenced ground, pin 2 high (+) and pin 3 low (-). The outputs are electronically balanced and have male connectors with pin assignments identical to the input. Figure 11 illustrates the preferred interconnection between the controller and the power amplifier. When driving unbalanced lines, pin 3 should be shorted to ground.

To hook up the DMC-2181X controller to the power amplifier, connect the Sub Output of the controller to the input of the subwoofer amplifier. If two amplifier channels are used, a Y-cord should be used to direct the signal into the input of both amplifier. The High Outputs of the controller are connected to the inputs of full-range DeltaMax™ controllers (like the DMC-1122X or DMC-1152X).

The outputs of the subwoofer amplifiers are then connected to the DMS-2181 speaker system. For the configuration where each driver is driven by its own amplifier (see Figure 11): connect one driver in the DMS-2181 to one amplifier making Pin 1- negative and Pin 1+ positive, and connect the other driver to the second amplifier making Pin 2- negative and Pin 2+ positive. For the configuration where the two drivers are paralleled on a single amplifier channel (see Figure 11): connect both drivers to the amplifier channel by making Pins 1- and 2- negative and Pins 1+ and 2+ positive. See the LOUDSPEAKER CONNECTIONS section for details of the loudspeaker wiring.

A Sense line must be connected to the DMC-2181X controller so that the power levels being delivered to the subwoofer drives can be monitored. For the configuration where each driver is driven by its own amplifier: connect the output of one of the subwoofer amplifiers to the Sub Sense Input on the controller. (Do not connect another sense line to the output of the other amplifier—that would short the two amplifiers together.) Note that because the amplifiers are identical and both drivers are driven at the same level, both will be protected by the controller. For the configuration where the two drivers are paralleled on a single amplifier channel: connect the output of that subwoofer amplifier to the Sub Sense Input on the controller. The sense input connector is a 5-way binding post wired in a floating differential configuration. This configuration makes it possible to connect sense lines to a bridged amplifier without shorting out one of the legs of the amplifier. High-quality banana plugs may be used for these connections, but wires underneath the binding posts provide greater security. Small gauge wire (e.g., 22 gauge) is acceptable for these connections because there is minute current flow, but be sure the connections are secure and safe enough for the high voltages from the amplifier output.

The gain control bus in the DMC controllers is accessible through a two-conductor 1/4-inch jack on the back of the controller. This feature is used when it is desired for the

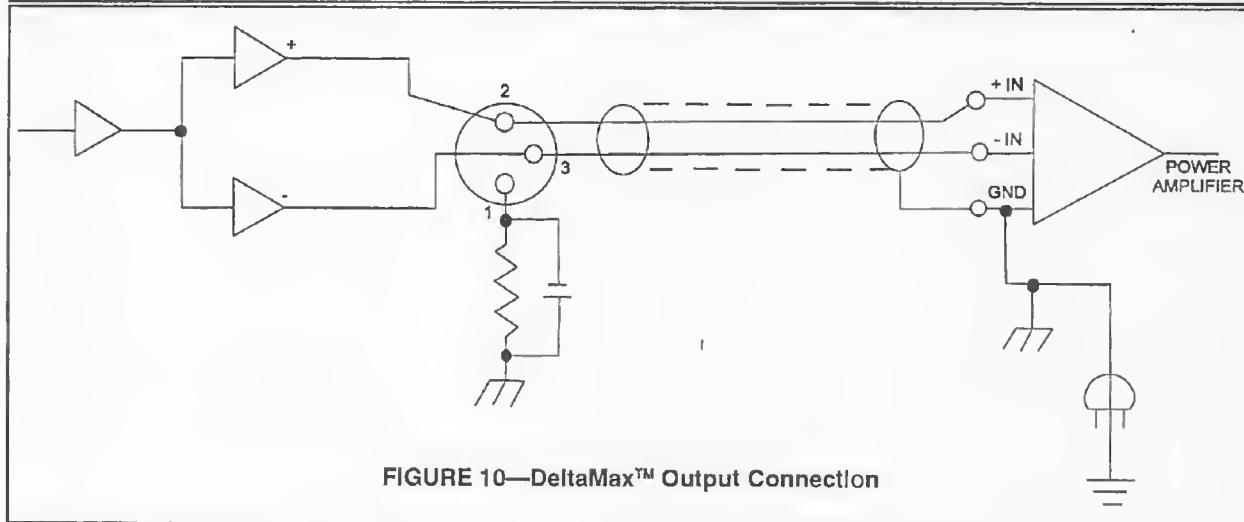


FIGURE 10—DeltaMax™ Output Connection

### INSTALLATION (continued)

gain of two or more units to track. Using a standard 1/4-inch patch cable, connect the jacks together. For more than two units, use Y-connectors. For example:

1. When multiple DMC-2181X controllers and loudspeakers are used, the controller's Gain Control jacks should be connected together to maintain level balancing and imaging.
2. When the DMC-1122X/DMS-1122/85 and DMC-1152X/DMS-1152/64 full-range systems are used with the stereo DMC-2181X/DMS-2181 subwoofer system, the controller's Gain Control jacks should be connected together between the three controllers to ensure flat-frequency response when the controllers are operating in the protection mode.

### Loudspeaker Connections

The DMS-2181 subwoofer speaker system is equipped with 4-pin Neutrik Speakon™ NL4MP-R connectors for electrical connection to the two subwoofer drivers. Each cabinet has two identical connectors with parallel wiring for connecting additional DMS speaker systems. The mating cable-end connector's the NL4FC.

The pin connections are as follows:

Pin 1- = LF 1 (-)

Pin 1+ = LF 1 (+)

Pin 2- = LF 2 (-)

Pin 2+ = LF 2 (+)

Both low-frequency inputs present a nominal 8-ohm load to the amplifier.

### Multiple Loudspeaker Arrays

Arrays consisting of multiple of identical DeltaMax™ loudspeaker systems can be implemented in a variety of ways. There does not need to be one controller for every speaker cabinet. Generally, there only needs to be as many controllers as there are different program sources. For example: a monaural program source requires one sub controller and one full-range controller, a stereo program source with mono bass requires one sub controller and two full-range controllers, a stereo program source with stereo bass requires two sub controllers and two full-range controllers, etc. For the sake of simplicity, the follow-

ing discussion will be confined to the various possible connection schemes for arrays of identical loudspeakers with only one program source. (A stereo or multiple-source array can be broken down and analyzed as separate arrays, each having a separate program source.) Amplifier inputs, outputs and sense lines will be addressed in the discussion.

The outputs (Sub Out, LF Out, HF Out, etc.) of the DMC controllers are connected to the inputs of multiple amplifier channels through the use of Y-cords (or multiple Y-cords). The number of amplifier channels that can be driven by a single output of a controller is limited only by the total combined input impedance of the paralleled amplifiers. The DeltaMax™ controller outputs can drive a combined impedance of 600 ohms or greater. (For example, sixteen amplifiers, each having an input impedance of 10 K ohms, can be paralleled off of one DMC output.) If it is necessary to parallel additional amplifiers, line-level distribution amplifiers will have to be employed to drive the amplifier inputs. (Alternatively, multiple DMC controllers with paralleled inputs could be used to distribute the amplifier load.)

For the case where all of the DeltaMax™ loudspeakers are paralleled on the output of a single amplifier channel and only one controller is used, the sense line to that controller is connected to the output of the amplifier. In this case, all of the loudspeakers are driven at the same level and the controller monitors the voltage drive to each speaker. Make sure that the amplifier is calibrated to the amplifier (see AMPLIFIER/CONTROLLER CALIBRATION section.)

For the case where the DeltaMax™ loudspeakers are powered by multiple amplifiers, all driven at the same level and only one controller is used, the sense line to that controller is connected to any one of the amplifier outputs. Note that this requires the use of identical amplifiers, each calibrated for 32 dB of gain, and that the controller is calibrated to the amplifiers (see AMPLIFIER/CONTROLLER CALIBRATION section). Although the controller is only actually sensing one amplifier and one set of loudspeakers, they all are being protected equally as long as all of the amplifiers are performing identically.

**INSTALLATION (continued)**

For the case where the DeltaMax™ loudspeakers are powered by multiple amplifiers, each driven at different levels and only one controller is used, the sense line to that controller is connected to the output of the amplifier that is delivering the highest power levels to the loudspeakers. This is a fairly common occurrence: where the levels of individual loudspeakers in an array are adjusted to provide even room coverage. In this case, the amplifier being sensed must be calibrated for 32 dB of gain and the controller is calibrated to that amplifier. (See AMPLIFIER/CONTROLLER CALIBRATION section.) The other amplifiers must be identical to the one being sensed, with the exception that their levels are turned down as necessary to obtain even room coverage. Although the controller is actually sensing only one amplifier and one set of loudspeakers, they are all being protected because the one being protected because the one being driven the hardest is triggering the protection.

Note in the last two examples where multiple amplifiers are used to power multiple loudspeakers in an array, the level setting and calibration of the amplifiers are critical to ensure that all of the loudspeakers are protected with only one sense line. If, in normal course of operation, the level settings of the amplifiers are likely to be tampered with, the system should be set up with one controller per amplifier, allowing each set of speakers to be monitored. In this case, each amplifier would be calibrated for 32 dB of gain and any level adjustment of loudspeakers would be done with the Output Level trim pots on the controllers.

**SPEAKER INSTALLATION**

The DMS-2181APF is the flying version of the DMS-2181AP. Each cabinet has a total of four lengths of aircraft-type L-track rigging hardware (two on the top and two on the bottom). This two-point flying system makes maximum use of the compact cabinets, permitting a wide range of angle adjustment and offering maximum flexibility in array design and implementation for both the touring sound company and the sound contractor. The track accepts the New Haven NH32101-2, and the New Haven NH8192-2S and Ancro 42546-10 single-stud fittings. Electro-Voice offers a complete line of flying accessories to be used with the DMS speaker systems.

**\*\*\* CAUTION \*\*\***

The DMS-2181 APF speaker systems should be suspended overhead only in accordance with the procedures and limitation specified in the "DMS Loudspeaker System Flying Manual" which is packed with each flying speaker system.

**CONTROLLER INSTALLATION****Power Source**

The DMC-2181X comes prewired from the factory for operation at 120 volts. To operate at a different voltage, the primary wiring of the power transformer must be altered.

**\*\*\* CAUTION \*\*\***

Hazardous voltages and currents may be encountered within the chassis. The service information contained within this document is for use by Electro-Voice authorized warranty stations and qualified service personnel only.

To change the transformer primary wiring configuration, use the following procedure:

1. Unplug the DMC-2181X power cord from the ac power source.
2. Remove the seven screws securing the top cover. There are two screws on each side, two screws on the rear, and one screw in the front panel (center, top).
3. Locate the eight voltage select solder cups near the power transformer. Referring to Table I, reconnect the leads corresponding to the desired primary voltage.
4. Install the correct line fuse. See values in Table II.
5. Install the top cover with the seven screws.

Line Voltage	Line Fuse, Slow-Blow
100 V ac	0.175 A/250 V
120 V ac	0.175 A/250 V
220 V ac	0.100 A/250 V
240 V ac	0.100 A/250 V

**TABLE II**  
Main Fuse Selection Guide

**Mounting**

The DMC-2181X is one rack-space high (1 3/4 in.) and fits in a standard EIA 19-inch rack. To make wiring easier, mount the controller in a rack cabinet near the power amplifier(s).

**Grounding**

A widely accepted ground technique for audio systems is the single-point ground. The final configuration will be determined by the size of the system and by the type of equipment used in the system. However, the single-point grounding system is recommended as a starting point.

The interconnecting cables of line-level equipment, such as the DMC-2181X should have the shields connected at one point only. This point is usually the receiving end of the signal transmission. See Figure 10.

Never lift the third wire safety ground of the ac power cord. It protects against possible shock hazard.

When deciding how to ground the DMC-2181X in a particular system, note the controller's input and output. XLR-type connectors have pin 1 referenced through medium impedance to chassis ground. The connector handle chassis is grounded. Circuit ground ties to the chassis ground internally at one point. The input to the controller is active-differential, and the outputs are transformer-isolated.

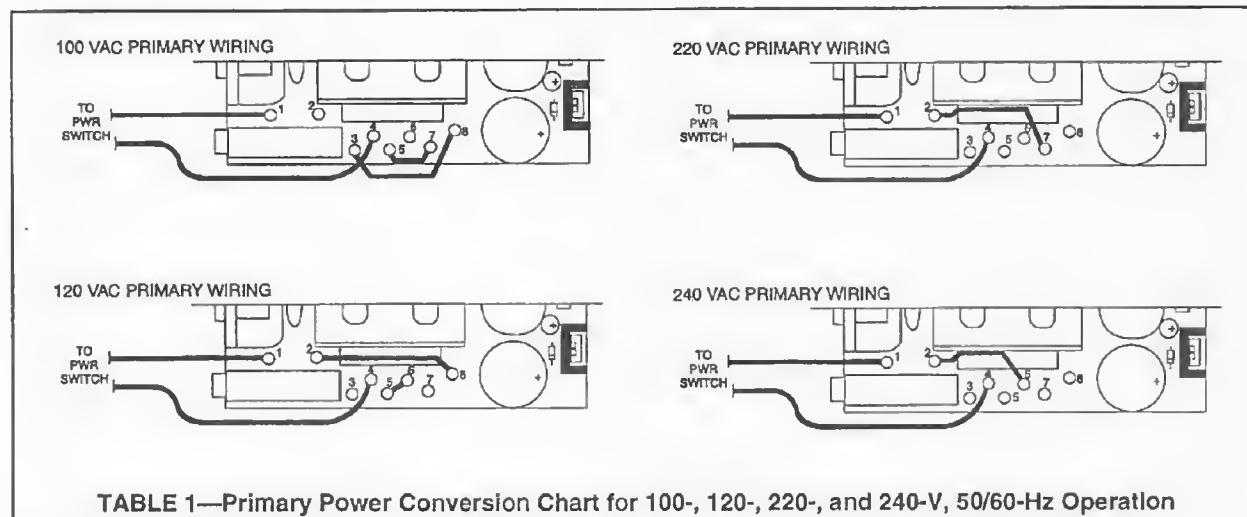


TABLE 1—Primary Power Conversion Chart for 100-, 120-, 220-, and 240-V, 50/60-Hz Operation

## INSTALLATION (continued)

### Ventilation

Provide adequate ventilation in the rack to maintain a reasonable operating temperature. The ambient temperature inside the rack cabinet should not exceed 60 °C (140 °F) under any conditions.

### Security

The system contains a security cover and two screws to protect the control setting against uninvited adjustments.

### Maintenance

Use a soft damp cloth to clean the unit. No other maintenance is required.

Item	EV Part No.
Complete Woofer	818-0882
Logo Nameplate Assy.	81680
Foam Grille	72717
Steel Grille Assy.	81704
Input Panel Sub-Assy.	81867
Input Connector	17305
Cable Connector	17306

## SERVICE INFORMATION

### SHIPPING DAMAGE

Inspect the shipping carton for possible damage. If the system arrives damaged, notify the transportation company immediately. Save the carton as evidence for the carrier to inspect. If damage occurs during shipping, it is the responsibility of the consignee to file a claim with the carrier. If the carton is in good condition but the unit is damaged, call Electro-Voice.

Included in the box with the DMC-2181X is a power cord, warranty card, two operating voltage labels, a 1/10 amp fuse for 220-240 V ac, and this manual.

### FIELD SERVICE

**WARNING:** No user serviceable parts inside. Extremely hazardous voltages and currents may be encountered within the chassis. The servicing information contained within this document is only for use by Electro-Voice authorized warranty repair stations and qualified service personnel. To avoid electric shock, DO NOT perform any servicing other than that contained in the Operating Instructions unless you are qualified to do so. Otherwise, refer all servicing to qualified service personnel.

**NOTICE:** Modifications to Electro-Voice products are not recommended. Such modifications shall be at the sole expense of the person(s) or company responsible, and any damage resulting therefrom shall not be covered under warranty or otherwise.

### Controller Power Inspection

If the power indicator does not light:

1. Check the power switch.
2. Check the power cord.
3. Check the fuse.
4. Check the primary (mains) voltage and DeltaMax™ controller operating voltage configuration.

### Driver Replacement

To access the drivers, first remove the foam grille. The grille may be removed by simply grabbing a corner and gently peeling it off. Next, remove the screws securing the metal grille screen. The screws can be easily removed with a #2 Phillips screwdriver; the screen can then be lifted off. Remove the eight 1/4-20 hex head bolts which secure each woofer. Use a 3/8-inch nutdriver or a ratchet with a 3/8-inch socket. The woofers then slide straight out of the enclosure.

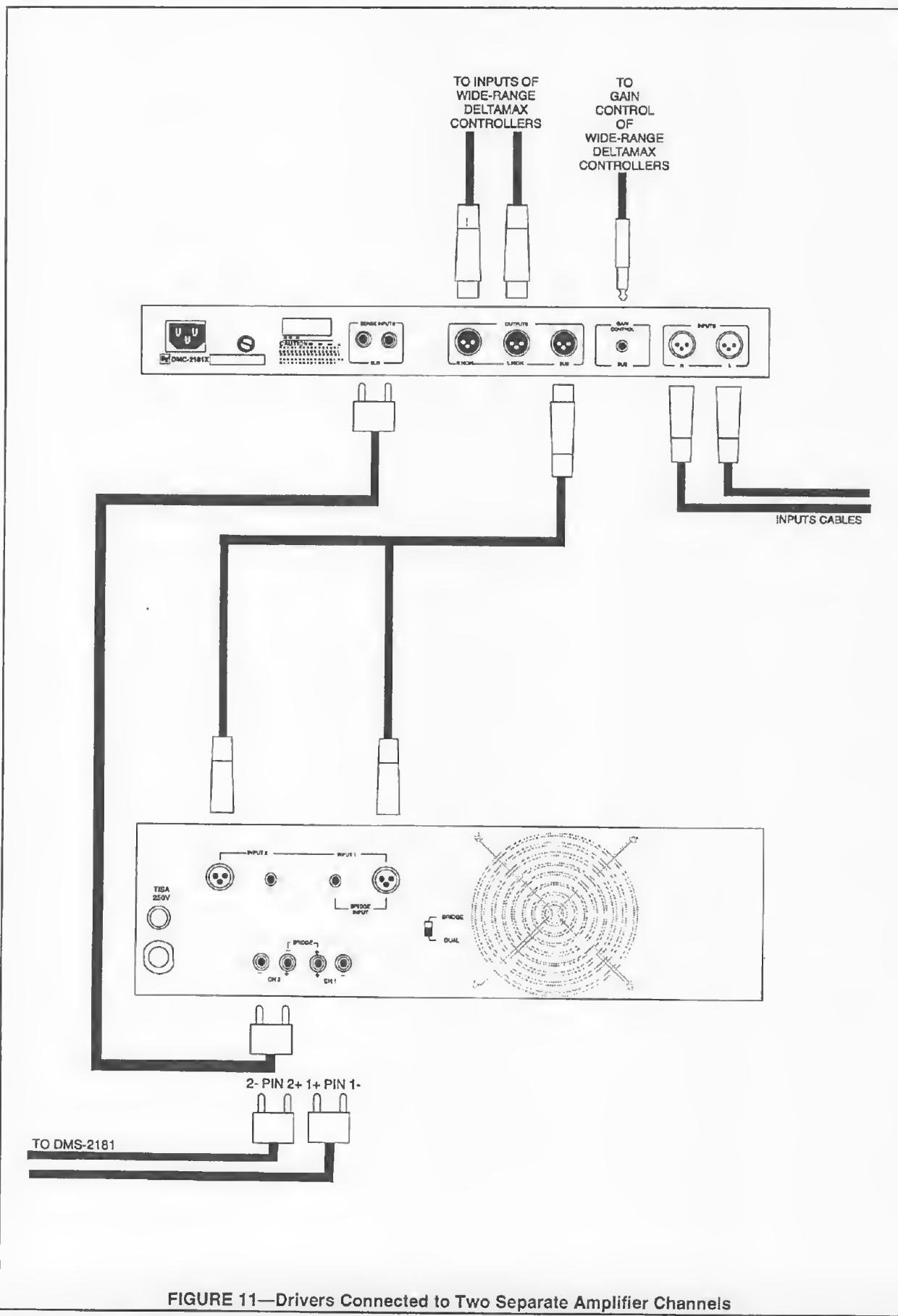


FIGURE 11—Drivers Connected to Two Separate Amplifier Channels

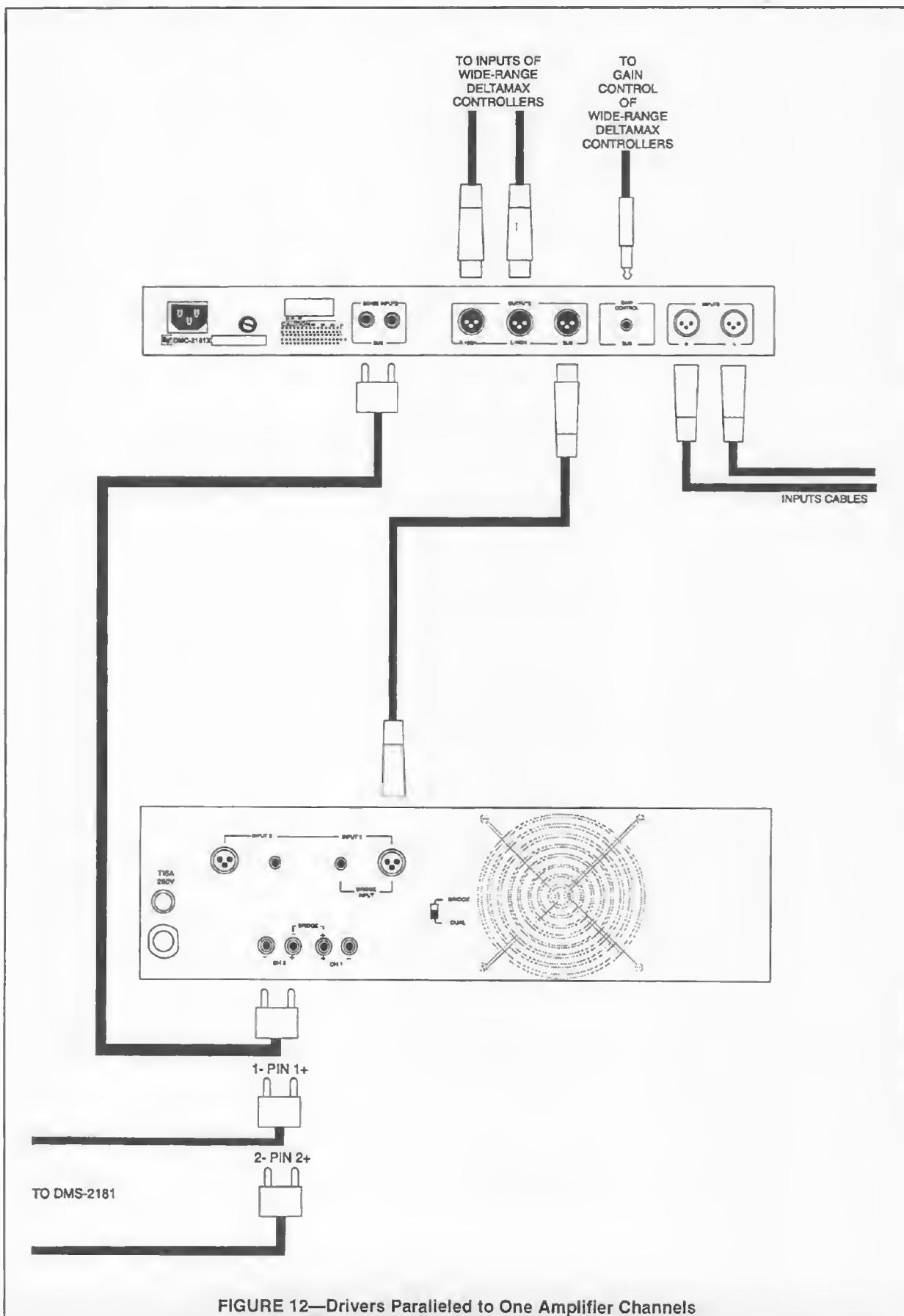


FIGURE 12—Drivers Paralleled to One Amplifier Channels

**Ordering Replacement Parts**

To order replacement parts, look up the order number from the component parts listing and call E.S.T. 616/695-6831, Fax 800/544-2153, for P.S.T. call 209/651-7777, or write:

Electro-Voice Service  
600 Cecil Street  
Buchanan, MI 49107 U.S.A.

**Technical Assistance**

For applications assistance or other technical information, contact the Technical Services Manager. You can call 616/695-6831, Fax 616/695-1304, or write: Electro-Voice, Technical Services Manager, 600 Cecil Street, Buchanan, MI 49107 U.S.A.

**WARRANTY (Limited)**

Electro-Voice products are guaranteed against malfunction due to defects in materials or workmanship for a specified period, as noted in the individual product-line statement(s) below, or in the individual product data sheet or owner's manual, beginning with the date of original purchase. If such malfunction occurs during the specified period, the product will be repaired or replaced (at our option) without charge. The product will be returned to the customer prepaid. **Exclusions and Limitations:** The Limited Warranty does not apply to: (a) exterior finish or appearance; (b) certain specific items described in the individual product-line statement(s) below, or in the individual product data sheet or owner's manual; (c) malfunction resulting from use or operation of the product other than as specified in the product data sheet or owner's manual; (d) malfunction resulting from misuse or abuse of the product; or (e) malfunction occurring at any time after repairs have been made to the product by anyone other than Mark IV Audio Service or any of its authorized service representatives. **Obtaining Warranty Service:** To obtain warranty service, a customer must deliver the product, prepaid, to Mark IV Audio Service or any of its authorized service representatives together with proof of purchase of the product in the form of a bill of sale or receipted invoice. A list of authorized service representatives is available from Mark IV Audio Service at 600 Cecil Street, Buchanan, MI 49107 (800/234/6831 or FAX 616/695/4743). **Incidental and Consequential Damages Excluded:** Product repair or replacement and return to the customer are the only remedies provided to the customer. Electro-Voice shall not be liable for any incidental or consequential damages including, without limitation, injury to persons or property or loss of use. Some states do not allow the exclusion or limitation of incidental or consequential damages so the above

limitation or exclusion may not apply to you. **Other Rights:** This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

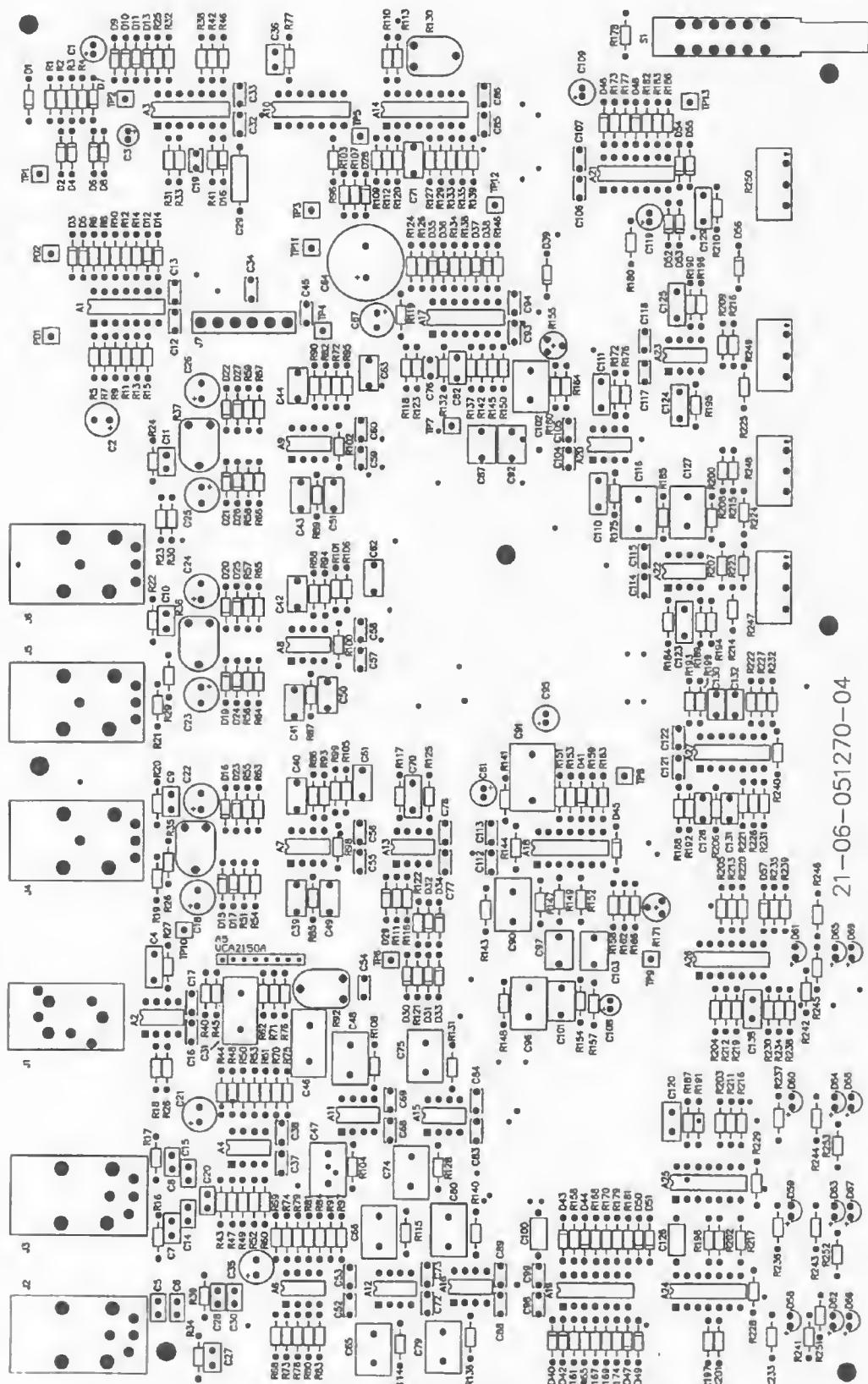
**Electro-Voice Speakers and Speaker Systems** are guaranteed against malfunction due to defects in materials or workmanship for a period of five (5) years from the date of original purchase. The Limited Warranty does not apply to burned voice coils or malfunctions such as cone and/or coil damage resulting from improperly designed enclosures. Electro-Voice active electronics associated with the speaker systems are guaranteed for three (3) years from the date of original purchase. Additional details are included in the Uniform Limited Warranty statement.

**Electro-Voice Electronics** are guaranteed against malfunction due to defects in materials or workmanship for a period of three (3) years from the date of original purchase. Additional details are included in the Uniform Limited Warranty statement.

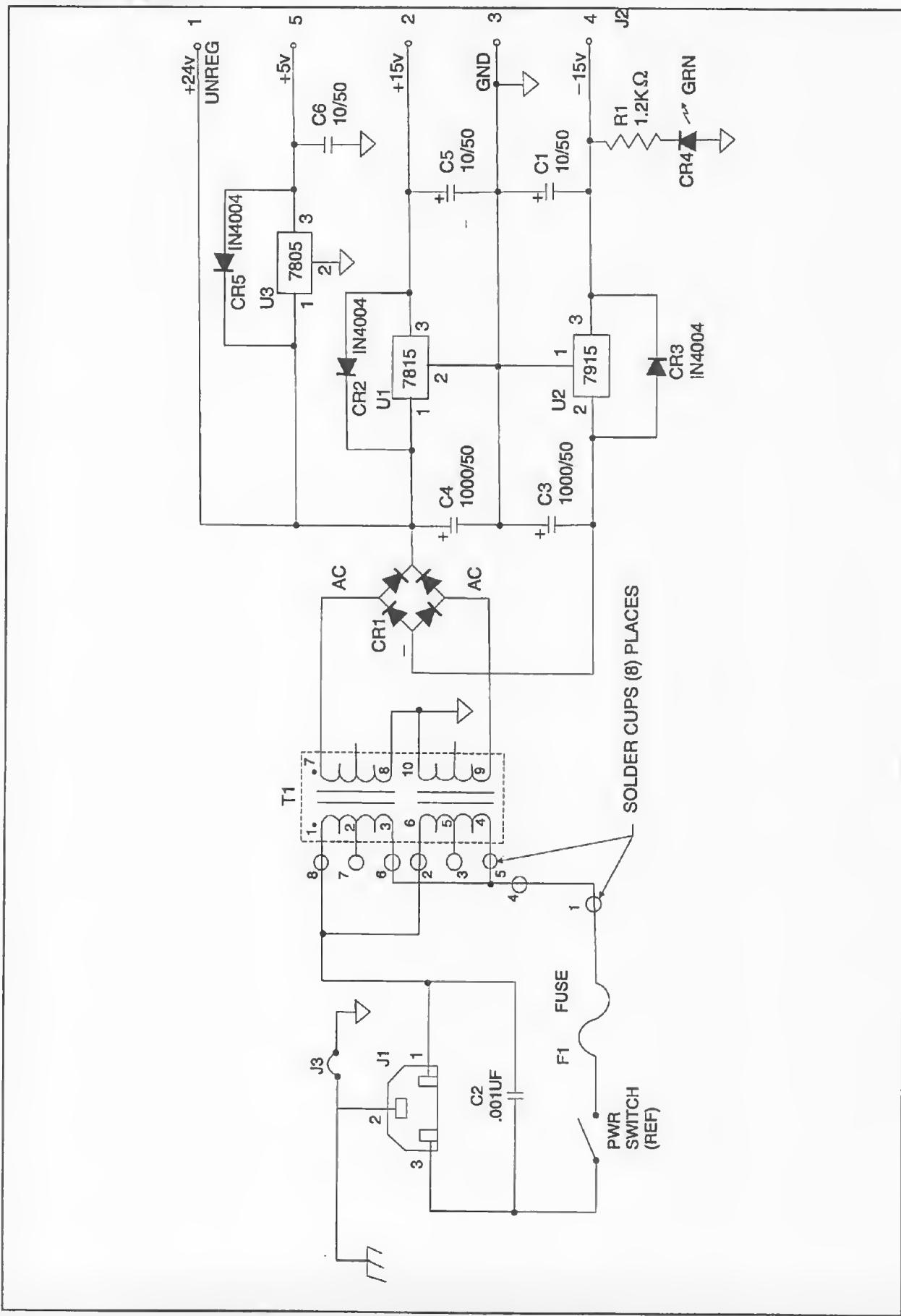
For warranty repair, service information, or a listing of the repair facilities nearest you, contact the service repair department at: 616/695-6831 or 800/685-2606.

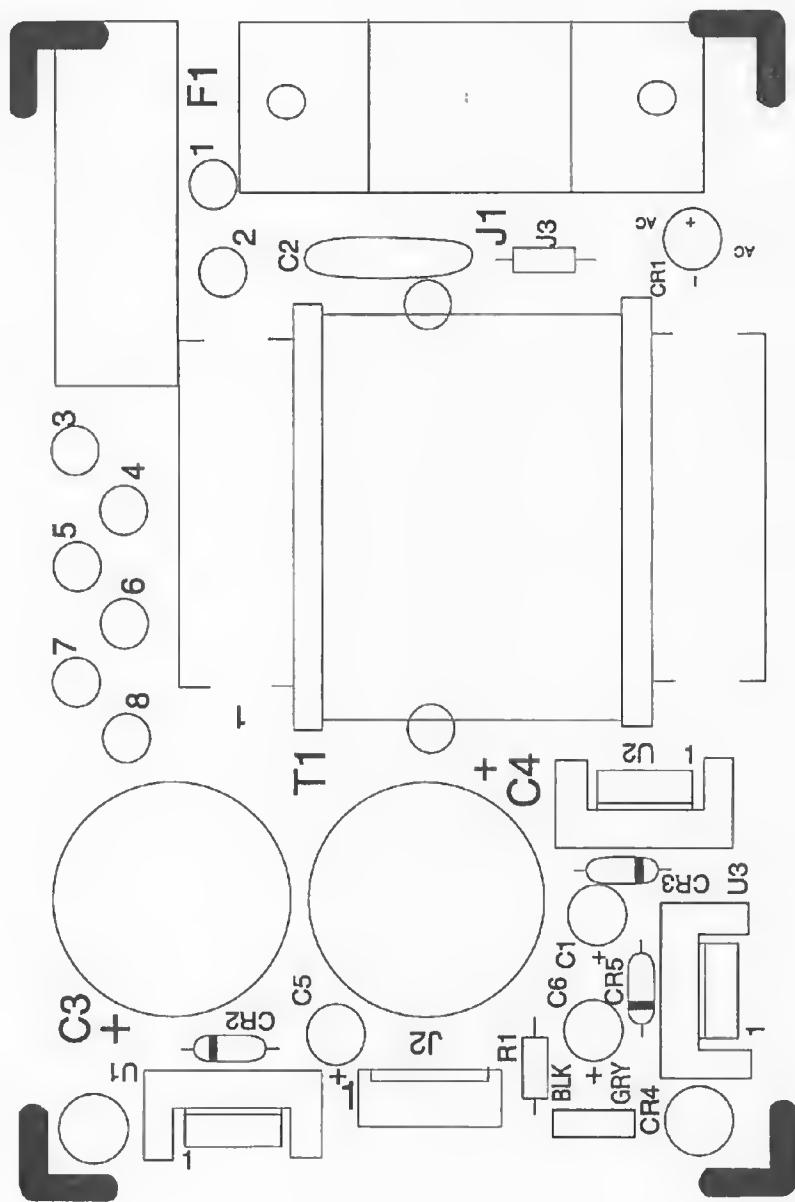
For technical assistance, contact Technical Support at 800/234-6831 or 616/695-6831, M-F, 8:00 a.m. to 5:00 p.m. eastern standard time.

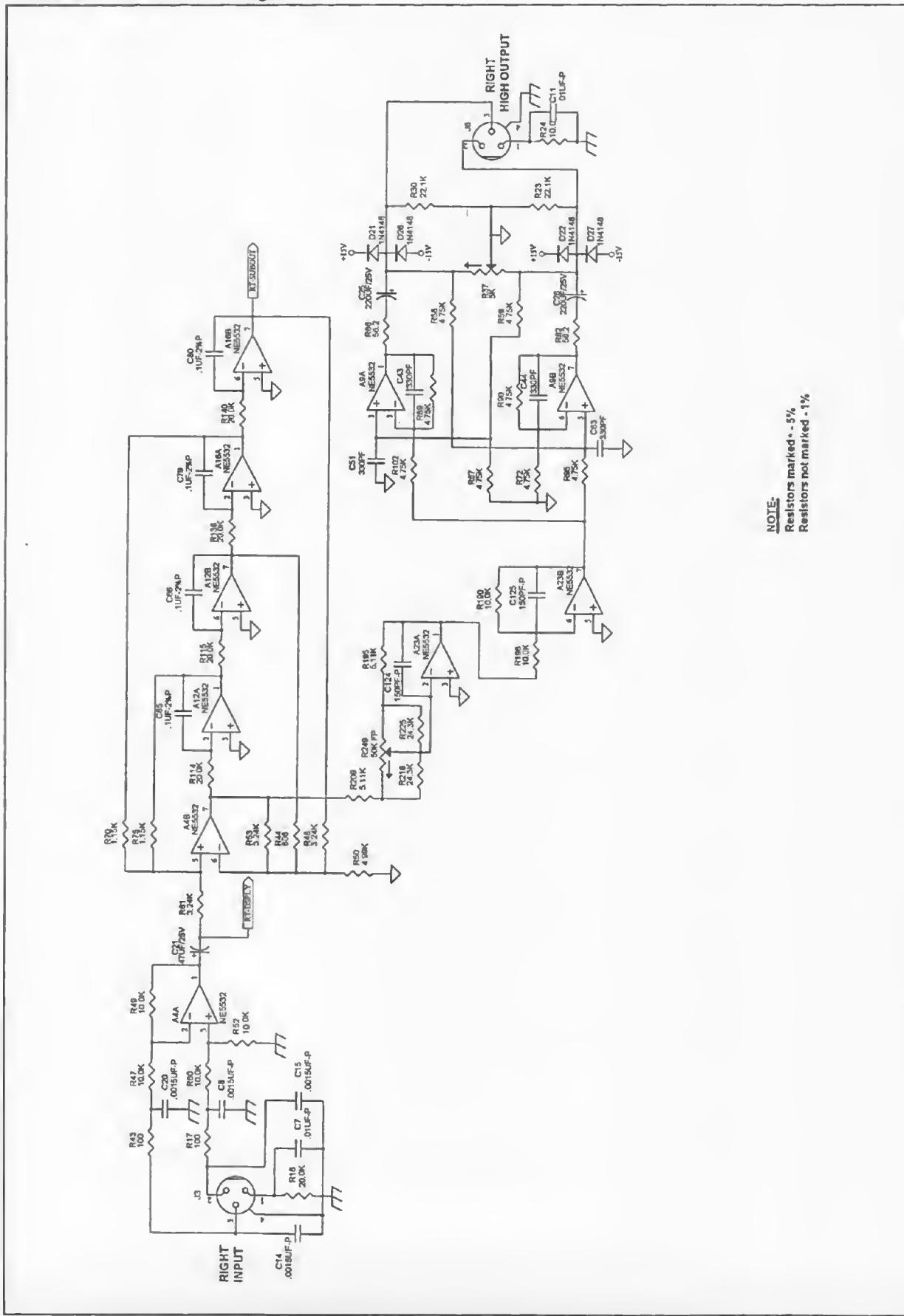
Specifications subject to change without notice.



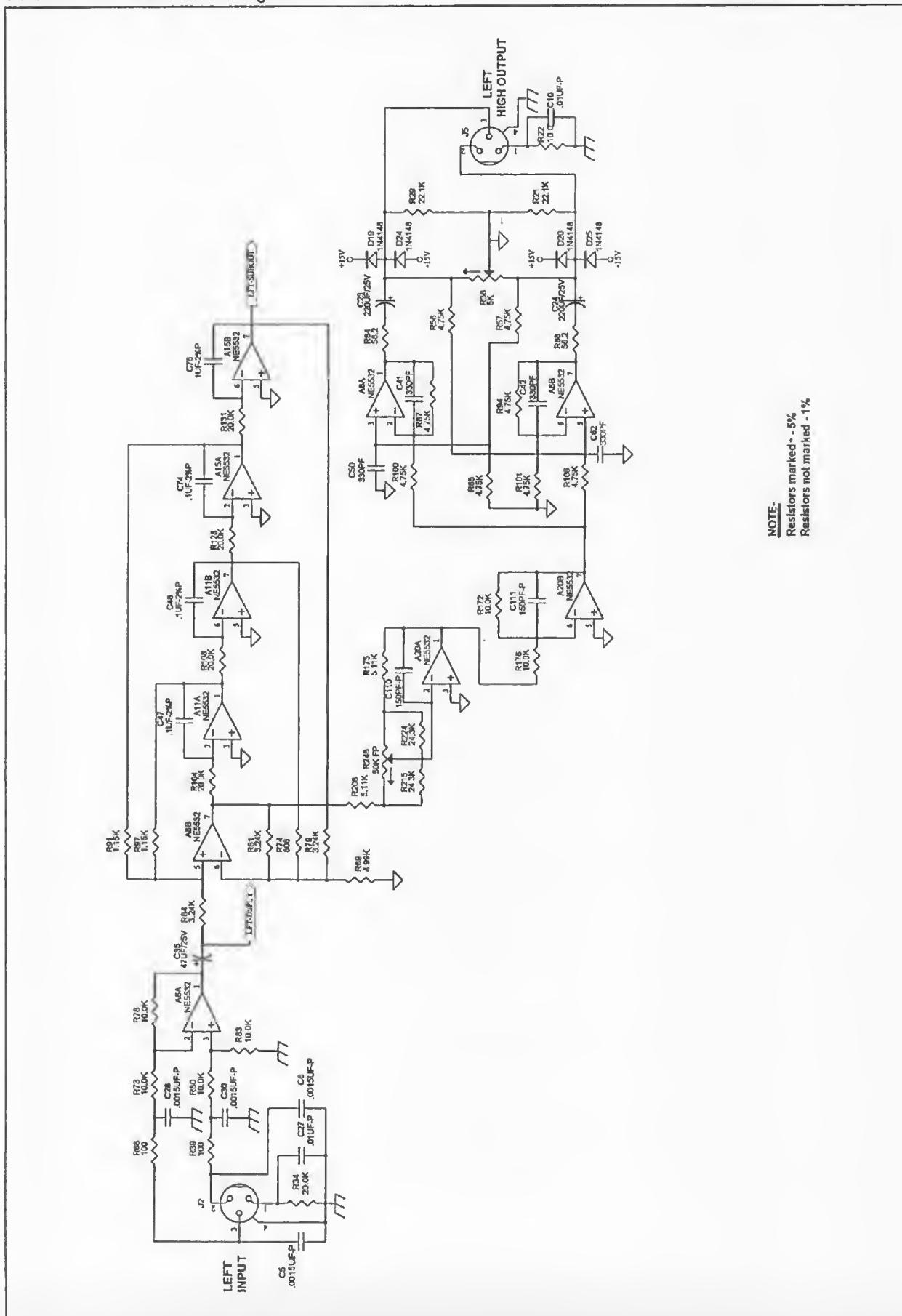
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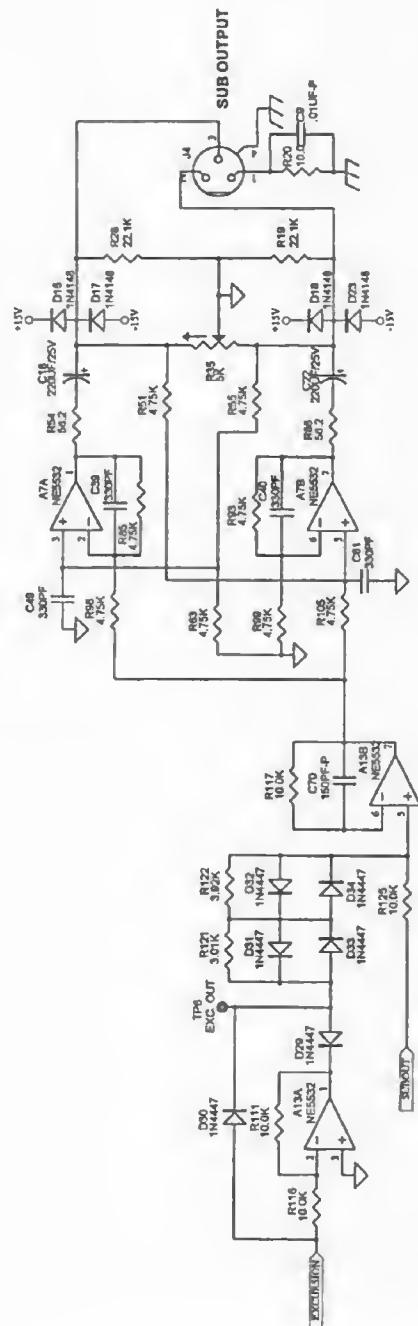




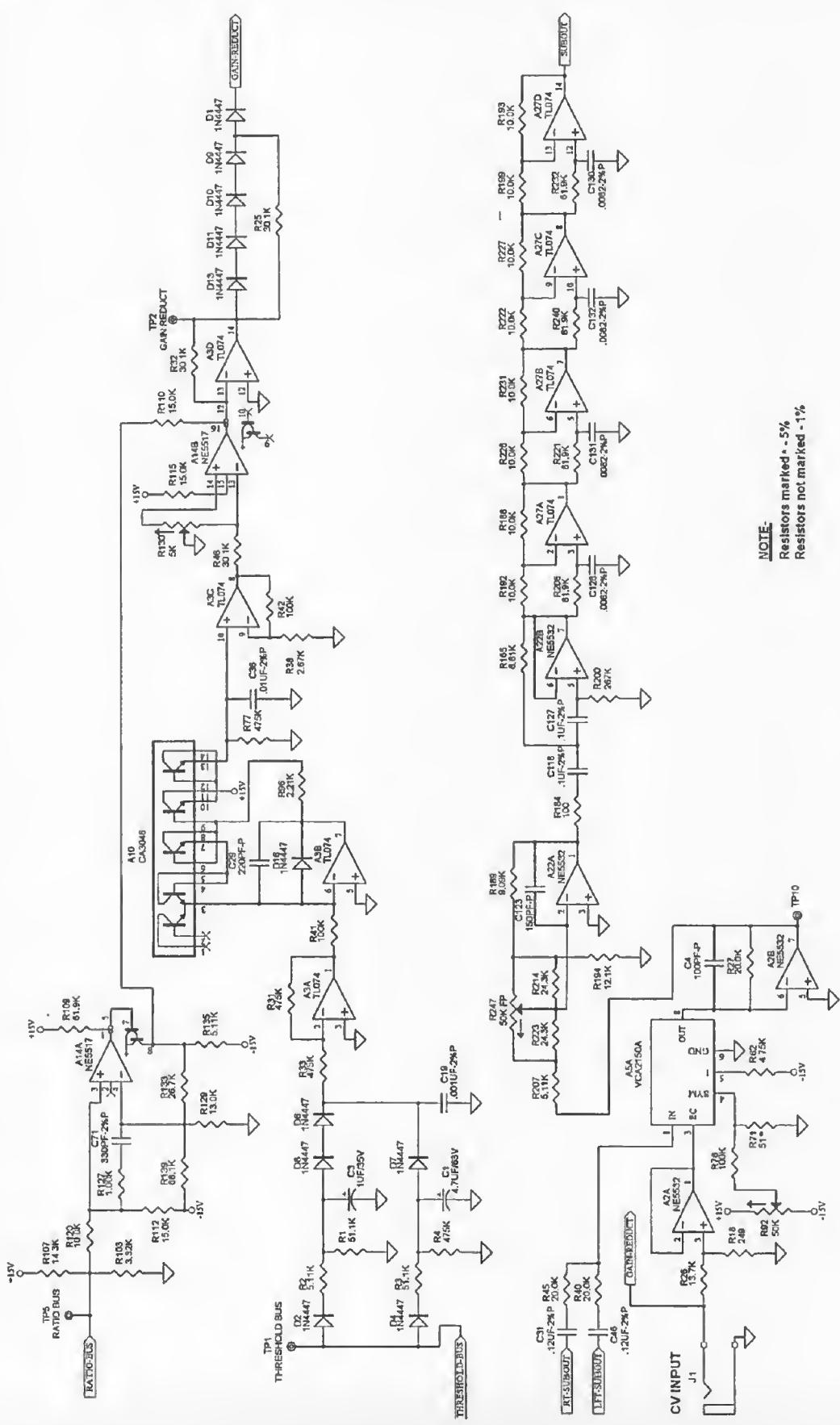
NOTE. Resistors marked - 5% Resistors not marked + 1%

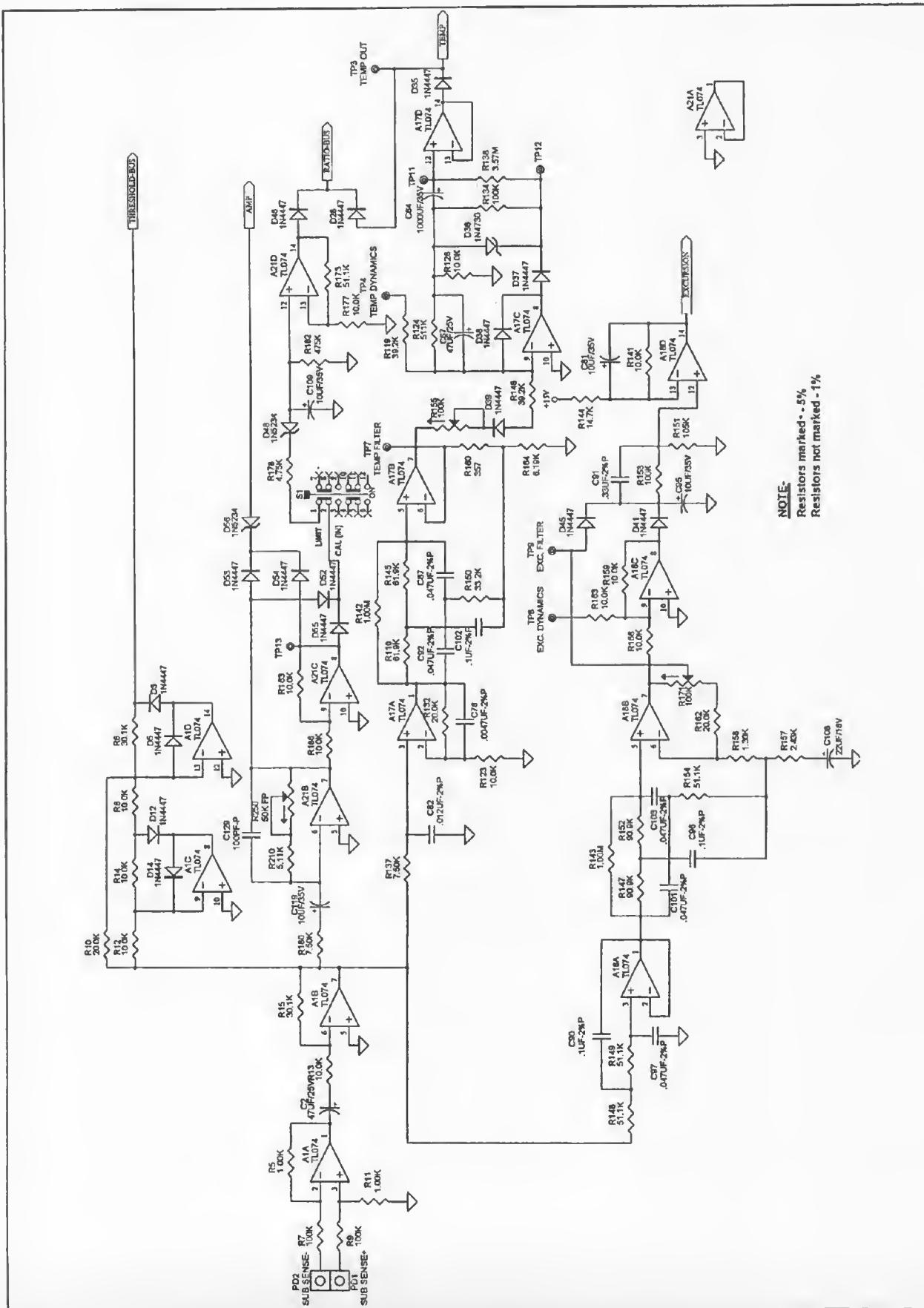
**NOTE-**

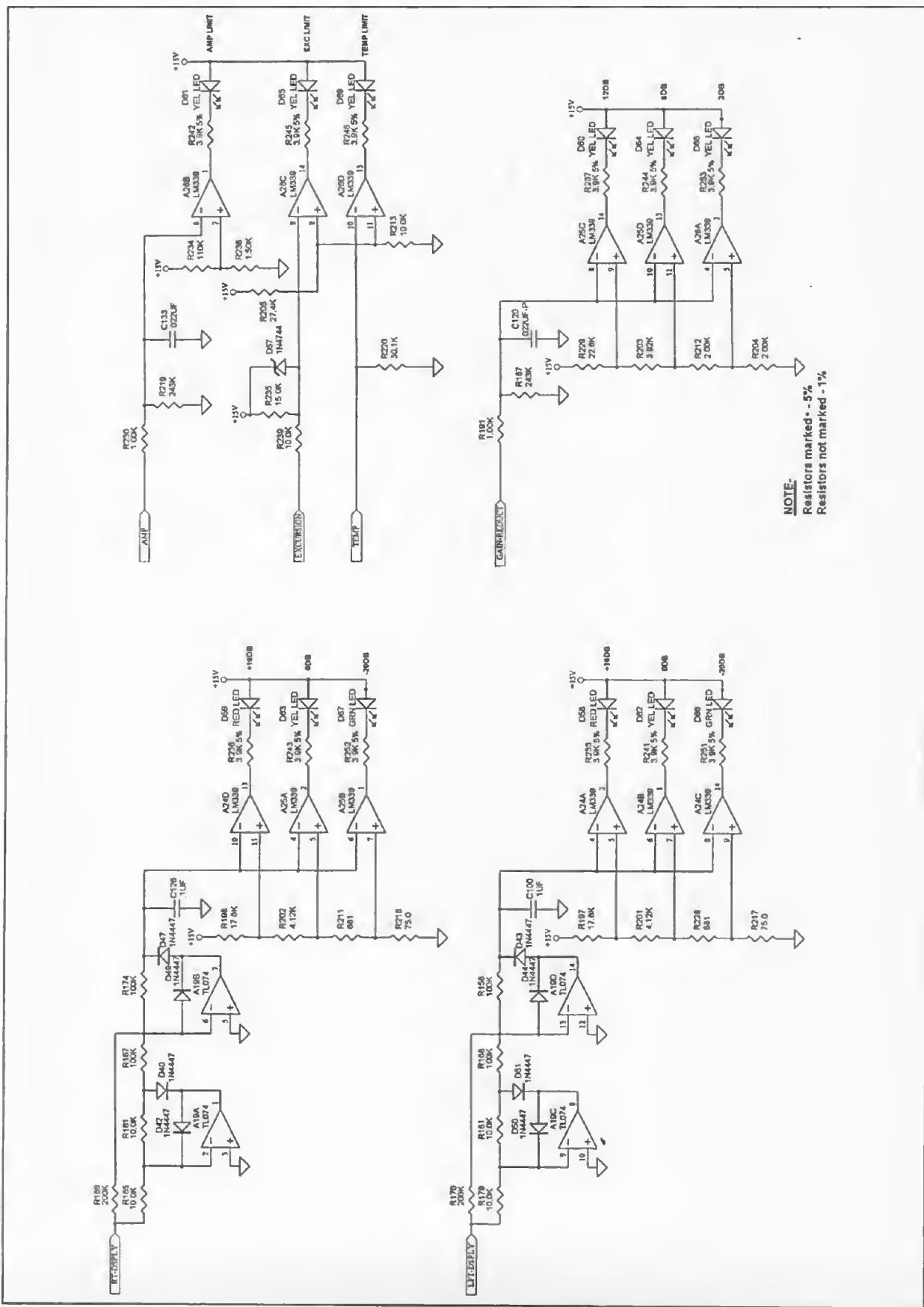
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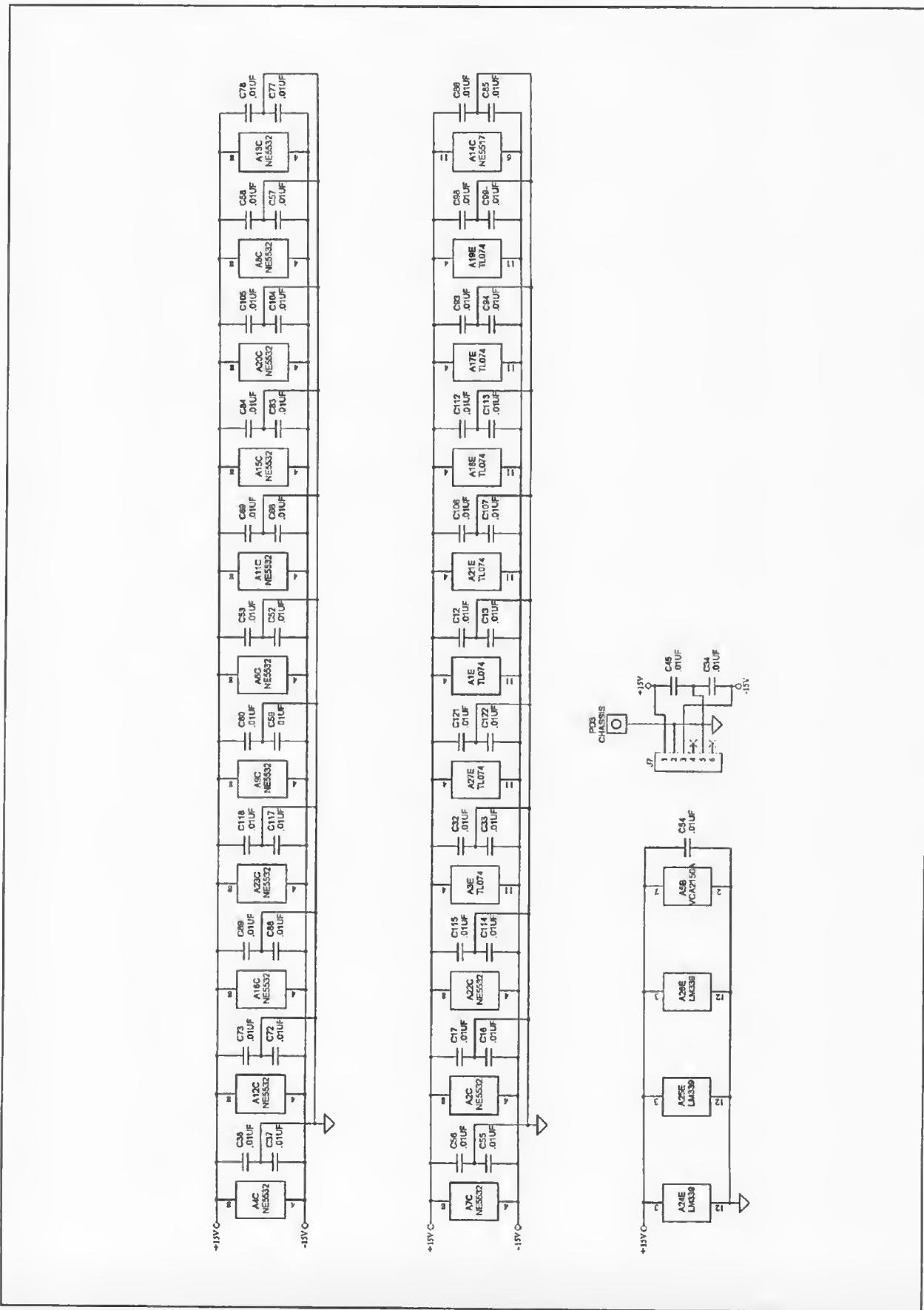
NOTE:  
Resistors marked - 5%  
Resistors not marked - 1%







NOTE- Resistor Resistor



## PARTS LIST

## Power Supply Board Assembly (27-01-038255)

C1, C5, C6	15-01-124502	Capacitor, 10uf, 50 volt, aluminum electrolytic, Radial Lead
C3, C4	15-01-124505	Capacitor, 1000uf, 50 volt, aluminum electrolytic, Radial Lead
C2	15-02-026884	Capacitor, 0.01uf, 250 volt, ceramic, UL approved
U1	17-01-121660	I.C., voltage regulator, +15V, LM7815
U2	17-01-121659	I.C., voltage regulator, -15V, LM7915
U3	17-01-119087	I.C., voltage regulator, +5V, LM7805
CR1	48-02-037580	Bridge Rectifier, 1.5 amp, pc mount
CR2, CR3, CR5	48-02-042787	Diode, 1N4004, 400V, 1A
CR4	39-01-124973	LED, green
F1	51-04-124634	Fuse, 175mA, 250V, slow blow
T1	56-08-025906	Transformer, power, pc mount
DMC-2181X Main Board Assembly		
C64	15-01-027317	CAP 1000MFD/35V ELEC AL RAD
C21, C35, C2, C67	15-01-027327	CAP 47MFD 20% 25V ELEC RAD
C108	15-01-028154	CAP 22 MF 16V ELECT AL RAD
C1	15-01-028703	CAP 4 7UF 63V ELEC AL RAD
C3	15-01-028850	CAP 1 MF 35V ELEC AL RAD
C18, C22, C23, C24,		
C25, C26	15-01-051325	CAP 220UF/25V ALUMINUM RAD LEAD
C81, C95, C109,		
C119	15-01-122935	CAP 10UF 20% 35V ALUMINUM
C70, C110, C111,		
C123, C124, C125	15-02-027325	CAP 150PF 5% 100V CERAMIC
C4, C129	15-02-027455	CAP 100PF 5% 50V CERAMIC
C71	15-02-028803	CAP 330PF 10% 50V CERAMIC
C39 THRU C44,		
C49 THRU 51,		
C61 THRU C63	15-02-051435	CAP 330PF 5% 50V POLYPROPYLENE
C12, C13, C16, C17, C32, C33, C34, C37,		
C38, C45, C52, C53, C54, C55, C56, C57,		
C58, C59, C60, C68, C69, C72, C73, C77,		
C78, C83, C84, C85, C86, C88, C89, C93,		
C94, C98, C99, C104, C105, C106, C107,		
C112, C113, C114, C115, C117, C118,		
C121, C122	15-02-100307	CAP .01UF+80% 100V-Z5U CER
C126, C100	15-01-124808	CAP .1UF/100V AXIAL
C5, C6, C8, C14, C15,		
C20, C28, C30	15-06-027320	CAP .0015MFD, 5%, 50V MYLAR
C133, C120	15-06-028020	CAP .022 MF 10% 50V MYLAR
C7, C9, C10, C11,		
C27, C36	15-06-028065	CAP .01 MF 2% 50 V POLY
C31, C46	15-06-028856	CAP .12 MF 10% 50V
C19	15-06-037649	CAP .001MF 2% 100V POLY
C76	15-06-037650	CAP .0047MF 2% 100V POLY
C87, C92, C97, C101,		
C103	15-06-037651	CAP .047MF 2% 100V POLY
C65, C66, C79, C80,		
C47, C48, C74, C75,		
C116, C127, C102,		
C96, C90	15-06-037653	CAP .1MF 2% 100V POLY

C128, C131, C132,		
C130	15-06-037655	CAP .0082MF 2% 100V POLY
C91	15-06-038211	CAP .33UF 2% 100V POLY
C82	15-06-038214	CAP .012UF 2% 100V POLY
C29	15-06-125113	CAP 220PF POLYSTY RENE/FOIL
A24, A25, A26	17-01-028867	IC LM339 QUAD COMPARATOR
A5	17-01-028905	IC VOLTAGE CONTROLLED AMP
A10	17-01-028906	IC CA3046 XSTR ARRAY
A14	17-01-028907	IC NE5517N O.T.A.
A2, A4, A6, A7, A8, A9, A11, A12, A13,		
A15, A16, A20,		
A22, A23	17-01-122832	IC-BI 5532A-DUAL OP-AMP 4MV
A1, A3, A17, A18,		
A19, A21, A27	17-01-124461	IC TL074CN QUAD OP-AMP
J7	21-01-028470	HDR .045 SQ PST 6 PIN
J1	21-01-028908	CONN 1/4 PHO JCK, RGT ANGLE
J2, J3	21-01-124470	CONN XLR FEM RTANG PCMT GND
J4, J5, J6	21-01-124642	CONN XLR MALE RTANG PCMT
D66, D67	39-01-028846	LED 3.9V ROUND, GREEN
D58, D59	39-01-028893	LED 2.0V ROUND, RED
D60, D61, D62, D63,		
D64, D65, D68 D69	39-01-028894	LED 2.0V ROUND YELLOW
R71	47-01-028860	RES 51 OHM 5% .25W CF AX
R233, R236, R237,		
R241, R242, R243,		
R244, R245, R246,		
R251, R252, R253	47-01-102092	RES 3.9 KHM 5% .25W CF AX
R187, R219	47-03-026839	RES 243 KHM 1% .25W MF AX
R44, R74	47-03-027328	RES 806 OHM 1% .25W MF AX
R133	47-03-027330	RES 26.7 KHM 1% .25W MF AX
R185	47-03-027374	RES 6.81 KHM 1% .25W MF AX
R7, R9, R134, R153,		
R41, R42, R76, R167,		
R174, R156, R168	47-03-028173	RES 100 KHM 1% .25W MF
R189	47-03-028176	RES 9.09 KHM 1% .25W MF
R214, R215, R216,		
R223, R224, R225	47-03-028178	RES 24.3 KHM 1% .25W MF
R107	47-03-028207	RES 14.3 KHM 1% .25W MF
R144	47-03-028208	RES 14.7 KHM 1% .25W MF
R204, R212	47-03-028210	RES 2 KHM 1% .25W MF
R169, R170	47-03-028230	RES 200 KHM 1% .25W MF
R124	47-03-028231	RES 511.0 KHM 1% .25W MF
R129	47-03-028237	RES 13 KHM 1% .25W MF
R110, R112, R113,		
R235	47-03-028238	RES 15 KHM 1% .25W MF
R1, R3, R148, R149,		
R154, R173	47-03-028240	RES 51.1 KHM 1% .25W MF
R122, R203	47-03-028241	RES 3.92 KHM 1% .25W MF
R19, R21, R23, R28,		
R29, R30	47-03-028243	RES 22.1 KHM 1% .25W MF
R139	47-03-028245	RES 68.1 KHM 1% .25W MF
R121	47-03-028248	RES 3.01 KHM 1% .25W MF
R150	47-03-028259	RES 33.2 KHM 1% .25W MF
R234	47-03-028269	RES 110 KHM 1% .25W MF
R2, R135, R175,		
R195, R207, R208,		
R209, R210	47-03-028695	RES 5.11 KHM 1% .25W MF AX
R151	47-03-037198	RES 105 KHM 1% .25W CF AX
R26	47-03-037659	RES 13.7 KHM 1% .25W MF AX
R103	47-03-037660	RES 3.32 KHM 1% .25W MF AX

R17, R39, R43, R68,			D1 THRU D14, D16, D28 THRU D35,
R184	47-03-037770	RES 100 OHM 1% .25W MF AX	D37 THRU D47,
R147, R152	47-03-038076	RES 90.9 KHM 1% .25W MF AX	D49 THRU D55 48-01-027340 DIO SIGNAL 1N4447
R138	47-03-038077	RES 3.57 MHM 1% .25W MF AX	D48, D56 48-01-028163 DIO ZENER 6.2V IN4744
R211, R228	47-03-038176	RES 681 OHM 1% .25W MF AX	D57 48-01-028891 DIO ZENER 15V IN4744
R4, R31, R33, R77,			D36 48-01-028896 DIO ZENER 3.9V IN4730A
R182	47-03-038217	RES 475 KHM 1% .25W MF AX	D15, D17, D19, D20,
R38	47-03-038219	RES 2.67 KHM 1% .25W MF AX	D21, D22, D23, D24,
R217, R218	47-03-038222	RES 75 OHM 1% .25W MF AX	D25, D26, D27 48-01-051327 DIODE 1N4148
R158	47-03-038293	RES 1.30 KHM 1% .25W MF AX	S1 51-02-028058 SW PUSH VERT PC 4PDT 10F4 S
R200	47-03-038294	RES 267 KHM 1% .25W MF AX	
R160	47-03-038295	RES 357 OHM 1% .25W MF AX	
R54, R64, R66, R82,			
R86, R88	47-03-051434	RES 56.2 OHM 1% 1/4W MF	
R201, R202	47-03-108444	RES 4.12 KHM 1% .25W MF AX	
R10, R16, R27, R34, R40, R45, R104,			
R108, R114, R115, R128, R131, R132,			
R136, R140, R162	47-03-109434	RES 20 KHM 1% .25W MF AX	
R8, R12, R13, R14, R47, R49, R52, R60, R73, R78,			
R80, R83, R111, R116, R117, R120, R123, R125,			
R126, R141, R159, R161, R163, R165, R166, R172,			
R176, R177, R179, R181, R183, R186, R188, R190,			
R192, R193, R196, R199,			
R213, R222, R226, R239			
R227, R231	47-03-109437	RES 10 KHM 1% .25W MF AX	
R109, R118, R145, R206,			
R221, R232, R240	47-03-119034	RES 61.9 KHM 1% .25W MF AX	
R5, R11, R127, R191,			
R230	47-03-121532	RES 1 KHM 1% .25W MF AX	
R24, R22, R20	47-03-122803	RES 10 OHM 1% .25W MF AX	
R205	47-03-122858	RES 27.4 KHM 1% .25W MF AX	
R18	47-03-124486	RES 249 OHM 1% .25W MF AX	
R142, R143	47-03-124488	RES 1 MHM 1% .25W MF AX	
R6, R15, R25, R32,			
R46, R220	47-03-124615	RES 30.1 KHM 1% .25W MF AX	
R229	47-03-124657	RES 22.6 KHM 1% .25W MF AX	
R238	47-03-124669	RES 1.5 KHM 1% .25W MF AX	
R51, R55 TO R59, R62, R63, R65,			
R67, R72, R85, R87, R89, R90, R93, R94,			
R95, R98, R99,			
R100, R101, R102,			
R105, R106, R178	47-03-124672	RES 4.75 KHM 1% .25W MF AX	
R164	47-03-124673	RES 6.19 KHM 1% .25W MF AX	
R157	47-03-124677	RES 2.43 KHM 1% .25W MF AX	
R194	47-03-124685	RES 12.1 KHM 1% .25W MF AX	
R50, R69	47-03-124696	RES 4.99 KHM 1% .25W MF AX	
R48, R53, R61, R79,			
R81, R84	47-03-124697	RES 3.24 KHM 1% .25W MF AX	
R70, R75, R91, R97	47-03-124699	RES 1.15 KHM 1% .25W MF AX	
R197, R198	47-03-124724	RES 17.8 KHM 1% .25W MF AX	
R137, R180	47-03-124805	RES 7.5 KHM 1% .25W MF AX	
R119, R146	47-03-124837	RES 39.2 KHM 1% .25W MF AX	
R96	47-03-124957	RES 2.21 KHM 1% .25W MF AX	
R247, R248, R249	47-06-027344	POT 16MM VERT B50KHM K86 CC	
R130, R37, R36, R35	47-06-027459	POT 5 KHM TRIM	
R250	47-06-028055	POT 16MM VERT 50K-B 20% TBM	
R92	47-06-028818	POT 50K 10V PCB HORZ TRIM	
R155, R171	47-06-028910	POT TRIM 100K 6MM	